THE GLASS INDUSTRY
VOLUME 16, NUMBER 10, OCTOBER, 1935

MECHANICAL STRENGTH OF GLASS

Topic of Glass Division Summer Meeting

AT THE summer meeting of the Glass Division of the American Ceramic Society, held at Hammondsport and Willow Point on Lake Keuka, New York, a strong group of papers were presented on the special subject of the meeting, "The Mechanical Strength of Glass".

These papers and their discussion emphasized several matters which had been brought out very clearly by the vice-chairman of the Division in charge of the program, J. S. Gregorius of the Pittsburgh Plate Glass Company. These points were also stressed by Dr. F. W. Preston in his remarks opening the technical sessions in the absence of Mr. Gregorius. These salient points involve recognition of the facts: that glass breaks practically only under tension, and is immeasurably stronger under compression; that the thermal history, as it involves a degree of annealing, residual stress, and disannealing, has much to do with the strength of individual specimens; that lack of chemical homogeneity affects the strength and also the degree of annealing possible; that the character of the surface of test pieces is very important, particularly as to whether it is ground, fire-polished, or possesses chips or abrasions; that small specimens (fibers) show proportionally high strength moduli —raising the question of skin-effect; and that a small load or pressure, maintained for a long period of time is more effective in breaking glass than a larger load, briefly applied.

The papers presented dealt with all of these matters in turn and laid good foundations for later work to be more definitely quantitative.

In its brief business session, the Division heard a progress report from the Committee on Durability, also a brief outline by Dr. J. T. Littleton of the proposed work of the A. S. T. M. Committee on Strength of Glass. The excellent work of Mr. Gregorius in planning the program and the efficient and hospitable management of the meeting by Dr. Littleton received a vote of thanks.

Dr. Littleton's camp on the shores of Lake Keuka, where the Glass Division held its recent summer meeting.

J. C. Hostetter reported plans being made abroad for an International Congress of Glass Technology in England, in the summer of 1936, on the occasion of the twenty-first anniversary of the Department of Glass Technology at Sheffield. It was

VOTED that the Glass Division of the American Ceramic Society co-operate with the International Commission of Glass Technology in participating in the proposed congress of glass technology to be held in England in 1936, and that a committee be appointed to work with the American representative to develop details of the program. It is expected that the personnel of this committee will consist of the officers and trustees of the Division, *ex officio*, with other members representing various lines of glass manufacture and the universities.

Summaries of the individual papers follow in the order of their presentation:

Some Comments on Fundamentals, *By F. W. Preston.*

This paper, given by way of prologue (and the observations by Dr. Littleton at the end, by way of epilogue) were concerned less with the results of specific sets of tests than with the fundamental difficulties and mysteries underlying the erratic behavior of glass under test.

Dr. Preston called particular attention to certain limitations of the Theory of Elasticity, which at present remains the chief mathematical weapon of the investigator, but, although very useful within a restricted field, is not by any means adequate to the problems of breakage, and shows no sign of ever being adequate thereto.

In the first place the Theory is limited to Elastic stresses and strains; that is, to such as disappear entirely on removal of the applied load, but such stresses and distortions are rarely of any practical interest. It is the possibility of a thing being "overloaded" and "failing" that interests us, and on this subject the theory has a very minimum of information to offer.

Even the notion that the material fails when some stress or other exceeds the strength of the material for that sort of stress is not true in any general sense: it may be true as a play on words, but if an attempt be made to give it specific form by assigning numerical values to the term "strength" as a property of the glass, then it fails at once to represent the facts.

It looks as though we must go further back than the Theory, which assumes matter a continuum, and think in terms of atomic structure, which is discontinuous.

The theoretical "strength" of glass is very high, and the ordinary values found in commercial testing are not more than 1% of the theoretical and often much less than this. The fact that 99% or more of the theoretical strength is missing probably accounts for the great variability of test results. For if 98½% of the strength is missing, the residual strength (which is what we measure); viz, 1½%, is three times as great as if 99½% is still missing. In other words an error or variation of ±½% in the "missing" strength would involve a variation of ±50% in the observed or "residual" strength.

The commercial production of a material like "theoretical" gas, as light as aluminum, chemically more durable than the finest stainless alloys, and stronger than the best of nickel steels, would open a new era in civilization.

Structural Steel often helps out the Theory of Elasticity, by entering on a plastic range when the yield point is passed, and thus, usually, brings the actual stresses more into line with calculated ones, that is, as calculated by the engineer's simplified versions of the Theory. Glass does not assist in this way.

The plastic properties of steel are themselves "residual": a single crystal of absolutely pure iron is exceedingly soft and plastic, about like putty; we harden it in two ways, both of which are in the direction of making a metallic glass of it, and thereby we approximate the strength to be expected of a glass. But by a curious paradox, when we start with a true glass, we cannot get the strength theoretically due, but only a strength less than the commonest grades of commercial iron.

The Theory of Elasticity has failed to determine the stresses in some of the simplest cases, representing many of the commonest forms of glass articles.

The Theory does not envisage any such phenomenon as the spontaneous decrease of strength under steady load.

The speaker denied the existence of any such quantity as the "Compressive Strength" of glass, the thing actually measured in compressive tests being some defect or other of the experimental setup.

The mechanical properties of glass, even in its present deplorable state, were the most important ones in practice. The most valuable pieces of glass in the world, the big telescope reflector discs, were of value only for their mechanical properties; viz, their great rigidity and permanence of form.

For commoner brands of glass, also, the mechanical properties were usually important, and a great deal of empirical testing was going on, for the purpose of assuring the manufacturer that the glass was as good as usual; that is, that operations were proceeding normally and giving a normal, and therefore, by trade acceptance, satisfactory article. There was a disposition in law to hold that the manufacturer by these tests was undertaking to ensure that his articles would in all cases be suitable for any service they might be called on to stand. This was going a great deal farther than the manufacturer really figured he was going, because he does not know how roughly his wares will be handled in every individual instance, or how long they will be in use after they leave him.

An adequate understanding of what tests to apply, and what the results of the tests really show, is vital, and the subject is still very far from clear.

The Effect of Sustained Loading on the Strength of Electric Lamp Bulbs, *By John M. McCormick.*

The effect of sustained loading on glassware is of direct interest to bottle manufacturers. As the complex shapes of bottles involve considerable testing difficulties, glass laths or rods were suggested as suitable test specimens. The greatest difficulties in the use of laths is the element of uncertainty introduced by the cut edge and the impossibility of accurately determining the actual breaking stress due to the influence of the knife edges used in applying the load. Glass rods also present difficulties in that it is difficult to apply the load without disturbing the stress distribution. In the belief that a thin shelled spherical object would present a relatively simple stress

To give these celebrities name-tags, or to caption the pictures "glass men having a good time", seems just a trifle superfluous. But we do call attention to the variety of background for these groupings. Afloat, ashore, day or night, there's never a dull moment when the Glass Division gets together. Staff Photographers Hettinger and Hostetter took these pictures, and those on the pages following; some of them under very difficult lighting conditions.

system, electrical lamp bulbs were selected as a suitable test material.

Bulbs made on the Corning "399" Bulb Machine by the General Electric Co. and the Corning Glass Works were used because the product of this machine might be expected to be uniform and mechanically ideal. Actually the specimens used lacked the uniformity which was

sought: all were out of round and the thickness was not uniform around the periphery of the bulb. All tests were made on the precision testing machine.[1]

Due to the difficulty of sealing the bulbs in the testing machine a modified sealing method was devised in which a thin-walled, soft rubber sac of approximately the size and shape of the bulb and permanently attached to the machine acted as a container for the liquid. This arrangement transmits virtually all of the pressure to the glass. In the tests the load was applied at definite intervals by equal increments of about ten pounds per sq. in. Intervals of from 5 seconds to 3 hours were used.

As the testing machine is so designed that the pressure errors are negligible, the only other error is in the time observation. With tests longer than 30 sec. duration the time error becomes negligible. In the case of short time tests the reported time is slightly too long as the application of pressure increases cannot be instantaneous. The probable error of the tests is small, being of the order of three per cent of the whole.

In all cases there is a definite decline in strength as the time interval is increased. The rate of decline is comparable with that found for bottles and is much less than that which was observed for flat glass. The composition of the bulb glass is also similar to that of bottle glass. There is also a decrease in the rate of decline of strength for the longer periods, the strength appearing to approach a definite minimum value and indicating that there is a moderate stress which the glass will endure forever.

A comparison of the results of the different make bulbs shows a marked difference in the rate of decrease of strength. On a long time test the strengths are about the same. Difference in composition or annealing may be responsible for the difference found in the short time tests. The frosted bulbs tested were stronger than clear and the superiority persisted for all durations of test.

A discussion of the location and nature of the fracture was given in addition to the results obtained when the breaking stress is plotted against the logarithm of the duration of test. It is suggested that if the relation between strength and duration of test is to be expressed as a logarithmic (exponential) function, the logarithm of stress should be plotted against the duration of stress.

The results are not to be regarded as complete due to the enormous amout of time required for proper testing. The limited data accumulated to date prevents sweeping generalizations. It appears established, however, that if a piece of ware will stand up under a certain load for a few hours, it will endure nearly as great a load for weeks or possibly forever. It is suggested that in cases where short time tests are made (pressure ware), the stress the ware will stand on sustained loading should be known and allowance made for the known fact that the ware will not stand indefinitely a stress as high as the experimental value obtained in a short time test.

Effect of the Rate of Loading on the Breaking Strength of Glass, *By L. V. Black, Pittsburgh Plate Glass Co.*

Eighty samples of plate glass 2 x 10″ and approximately 7/64″ thick were cut from a single plate and were carefully examined for surface defects. The thickness of each sample was accurately measured to within 0.0001 for width. Ten samples were taken for each test and the average modulus of rupture determined.

The test was made by supporting the sample on two parallel ⅜″ cold rolled steel rods, 8″ apart. A third steel rod attached to a lever was pressed on the opposite side of the glass parallel to and exactly midway between the supports. The force was applied to the lever by running water into a pail from a constant level source. The rate of loading was regulated by varying the rate of flow of the water. After the specimen broke, a quick acting valve shut off the water supply. The rate of loading for each succeeding test was multiplied by three and varied from a minimum of 35 lbs. in 2430 seconds to a maximum of 35 lbs. in 10 seconds. Average results are:

Rate of Loading 35 Lbs.	Thickness	Time	Pounds	Mod. of Rupture
10 sec.	.117	7 sec.	24.3	10,765
30 "	.115	17.7 "	20.6	9,042
90 "	.117	45.0 "	17.5	7,701
270 "	.117	120.0 "	15.9	7,044
810 "	.117	360.0 "	15.6	6,913
2,430 "	.114	960.0 "	15.0	6,493

Two sets of 10 samples each were placed on supports 8″ apart and a load of 7 lbs. suspended from the center of each specimen of one set and a load of 10 lbs. from the center of those of the other set. The samples were left in this position for 20 days and checked at least once every 24 hrs. for breakage.

For the 10 lb. test, the results are as follows: One broke at the end of 1 hr; one in 1½ hrs., four at the end of 4 hrs., two at the end of 17 hrs., and one at the end of 40 hours. The tenth sample was still intact at the end of 20 days and when broken by the 35 lb. in 30 secs. test had a modulus of rupture of 9050.

In the 7 lb. test one broke in seven days while the remainder were unbroken at the end of the test period. The unbroken samples had not taken a permanent set and when tested by the 35 lbs. in 30 secs. test gave an average modulus of rupture of 8244.

The author concluded from the results of his tests that the wide variations observed makes it imperative that a standard method of testing be adopted and that specifications such as the span, width of sample, rate of loading and the like be standardized. A recommendation was made that a low modulus of rupture and a large factor of safety be allowed when calculating the strength of glass. The results of the tests also showed that the glass that has been loaded for a long period of time is immediately restored to nearly its original strength after the load is removed.

Strength of Flat Glass Under Uniform Loading, *By G. B. Watkins and R. W. Wampler.*

The increasing use of flat glass in aquarium, airplane windows, stratosphere balloons, etc., requires estimation of the amount of pressure such glass will withstand.

For samples, plate and sheet glasses in the form of 12 18 and 24″ squares and rectangles 12 x 16″; 12 x 20″; and 12 x 24″ with thickness varying from 1/10 to 1/4″ were used. The specimens were subjected to a uniform (hydraulic) loading in the following manner: The glass plates were fastened in a frame in such a manner that a water-tight compartment was formed in which the glass sample was one side and a steel plate the bottom side.

[1] F. W. Preston, "Pressure Testing Machines" Glass Ind. 15, 252, 1934.

The water from the pump was introduced through an opening in the steel bottom plate. In all cases the air in the compartment was vented before positive pressure was applied. Deflection measurements were also taken in connection with the pressure determination. The results are shown in Table Ia and Ib.

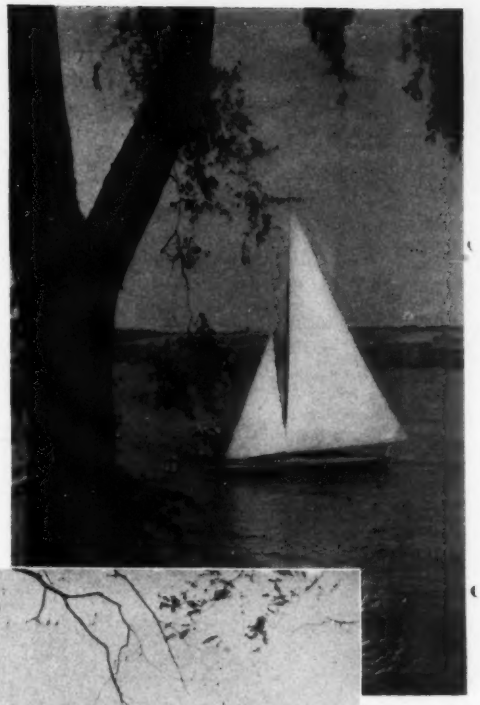
TABLE Ia. Pressure in lbs./sq. in. Required to Break Glass of the Following Dimensions

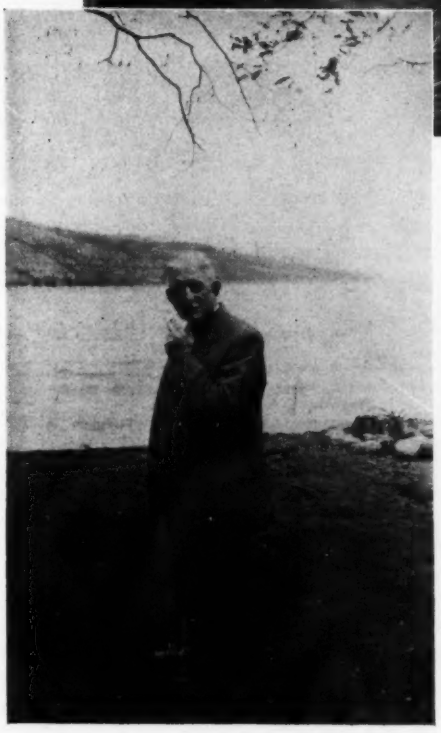
Thickness"	12x12"	18x18"	24x24"	12x16"	12x20"	12x24"
0.055	1.2	0.5	0.2	0.8	0.7+	0.7+
0.065	1.5	0.6	0.2+	1.0+	0.9+	0.9+
0.095	2.6	1.0	0.5	1.8	1.7	1.5
0.125	4.2	1.7	1.1	2.9	2.8	2.3
0.187	10.4	4.2	2.7	6.5	6.1	5.0
0.250	19.3	9.0	4.7	13.6	11.9	9.8

TABLE Ib. Deflection in Inches

Thickness	12x12"	18x18"	24x24"	12x16"	12x20"	12x24"
0.096	.134	.162	.161	.114	.138	.165
0.125	.108	.151	.184	.150	.113	.163
0.187	.110	.219	.245	.111	.113	.101
0.250	.115	.191	.256	.092	.113	.123

An inspection of the data obtained in these tests shows that within the range of dimensions of rectangles tested, the smaller dimension of the rectangle is not the determ-





These two boats are of the fastest type afloat—and their crews handled them superbly. The group in the center was momentarily disconcerted a few second after the picture was taken when the mast snapped short under a sudden gust of wind and buried all hands under a mountain of canvas.

ining factor of the strength of glass. If in the following equation

$$S = K \frac{a^2b^2}{2(a^2-b^2)} \cdot \frac{P}{t_2}$$

where S = maximum stress in lbs. per sq. in.
a and b = width and length
P = breaking pressure in lbs. per sq. in.
t = thickness
K = constant

we assume the value of 6000 for S and substitute the experimental values of a, b, P and t found, the constant K equals 0.61, 0.63, 0.59, 0.63, 0.67 and 0.66. If then a factor of safety is used in specifying the dimensions of glass necessary to withstand a certain pressure, the above formula (using a value of 0.63 for K and 6000 for S) may be used with safety.

The work reported is only preliminary, future work is planned in which different sizes and shapes are to be investigated. A different value for K may be found.

Proposed Method for Measuring Tensile Strength of Glass, *By C. J. Phillips, Corning Glass Works.*

The work described was undertaken to show that a relatively simple cantilever bending device could be built which would offer advantages over the equipment now available. In addition, the American Society for Testing Materials have recently requested standard methods for measuring glass strength. The nature of the work, therefore, was to show that despite improvements in apparatus and technique, variations in results can be expected if the method of treating glass surface is not standardized.

The details of the apparatus and its method of use were illustrated by the means of slides. In all tests an attempt was made to put on the glass an initial stress (due to the weight of the knife edge, etc. of the apparatus) equal to 50 per cent of the final average strength as determined by a few preliminary tests. All samples were loaded at a constant rate equal to a stress increase, for ordinary glass cane, of 5000#/in. 2/min. or 0.059 Kg./mm 2/secs. The method of calculating the stress at which the break occurred, for both round and "out-of-round" rods was described in detail. Any specimen breaking at points outside the upper edges was not considered.

The first test was performed with borosilicate cane drawn, without marvering, one week before the test. One group of samples were not at any time subjected to handling. Another group were treated in the usual way, no precautions being taken to prevent surface imperfection due to handling. The third group were hand polished with extra-fine emery while the fourth group were abraded by rubbing No. 1 emery cloth along and perpendicular to the axis of the cane. All four groups were then heat treated by heating from 20°C to 515°C, holding for four hours, and then cooling to 100°C at a rate of about 35° per hour. The strain in the annealed rods was about 0.03 Kg./mm². A second series of tests were also made on the same glass in the form of rods with flattened faces. The surface treatment consisted of giving one group a velvet finish, a second group a high polish and the third group an emery abrasion. All samples were heat treated as described.

Results of the tests are shown in the following table:

TENSILE STRENGTH

Classification*	No. Tested	Kg./mm² Min.	Kg./mm² Average	Kg./mm² Max.	Per cent Variation
Abraded—Slabs—Single	15	3.60	5.00	6.50	80.0
Abraded — Cane — Flat — Double	20	2.60	3.46	4.22	62.0
Abraded — Cane — Round — Double	20	2.90	3.50	4.41	52.0
Velvet—Slabs—Double	20	4.40	5.32	5.60	27.0
Velvet—Slabs—Single	20	5.58	6.47	7.77	39.0
Velvet—Cane—Flat—Double No. 1	20	4.92	6.57	7.93	61.0
Velvet—Cane—Flat—Double No. 2	20	4.80	6.75	7.60	58.0
Ordinary—Round—Double No. 1	20	3.90	5.45	8.20	110.0
Ordinary—Round—Double No. 2	20	4.71	7.23	9.27	97.0
Polished—Flat—Double	20	4.91	6.49	7.45	52.0
Polished—Round—Double	20	5.90	6.68	7.45	26.0
Untouched—Round—Double	20	12.70	19.50	42.80	337.0

*Single and double designates type of loading edge.

The effecct of the condition of the glass surface is very noticeable. Of greatest interest is the fact that despite the improved testing method, the measured average strengths vary from 3.50 to 19.5 kg./mm², a 550 per cent difference.

From the results obtained it is concluded that the use of some standardized treatment for the surfaces of flattened cane which is then broken with a double knife-edge cantilever arrangement would be a very desirable method for measuring the tensile strength of glass.

Some Factors Affecting the Impact Strength of Glass, *By James Bailey.*

The factors affecting the result obtained when sheet glass is tested by the impact method are very numerous. To reduce them somewhat, the tests were confined to sheet glass upon which steel balls of various sizes were dropped from various heights up to 95 inches. The sheet glass was single thickness (2.2mm.), and double thickness (about 3.5mm.). A few tests were made on ¼" plate glass on plates of ⅝" optical glass. The glass was cut to shape with a steel wheel cutter. Several supports were used such as (a) thin cloth diaphragm, which represented the case of no support (b) steel rings with various size of holes upon which the glass rested and (c) the same iron rings having the glass stuck on them with thickened glucose.

A preliminary set of experiments showed that the energy required to cause a concoidal fracture in a thick, heavy piece of glass increased markedly as the ball size increased up to a ball size of about ⅜" when the glass was soldidly backed up on an iron plate. The energy required by large balls up to one inch seemed to reach a maximum and then declined somewhat. When the glass was supported on soft wood, the energy required was approximately the same as on the iron support up to a ball size of 3.8". The required energy increased up to nearly double this amount with a half inch ball after which it was extremely erratic and decreased in value. It was evident that the erratic behavior with one half-inch balls and larger was associated in some way with the

vibrations which were set up in the glass by the impact.

In the next series of tests single thickness glass was cut into 2″ squares. The glass test piece was supported on a cloth diaphragm and a steel ball was dropped upon its center. The average height of drop to cause breakage varied from 95 inches with a ¼″ steel ball to 16 inches with a 1″ steel ball. The average energy required to cause breakage varied from a very small amount with the small ball to a large amount with the large ball. The shape of the energy curve was such that it approached zero for small high velocity balls and infinity for large low velocity balls. No satisfactory relation between the mass or velocity could be found.

In another series of experiments it was found that the height of drop of a ½″ ball required to break specimens of single strength sheet glass laid on a cloth diaphragm was nearly constant even though the size of the glass varied from one inch square to 4″ square.

A survey of all of the above tests showed that the breaks had originated at the edge of the sheet and not at the point of impact. In no case was there evidence of a concoidal fracture having been formed.

Tests wherein the glass sheets were supported on heavy iron rings and balls of ½″ and ⅝″ diameter were used showed the breaks were produced with a drop of 18″ on 2.16 to 2.4 mm. glass over a 7/16″ hold and the glass was stuck down with glucose. The breaks produced were splintering at the point of impact and shear around the edge of the hole. A drop of 60″ was required over a 1″ hole under the same conditions. The breakage over this size hold was partly at the center and partly around the edge of the hold. Breaks over a 1¼″ hold average somewhat less and many of these occurred in ring-like cracks just inside the iron with no breakage at the center. Holes of 2″ diameter and 5.4″ diameter gave average breaks at 47″ and 71″ respectively with some evidences of breaks

Attention will be called to only one of these interesting groups—salesmen training their guns on glassmen just before the order blank is produced. And if you'd seen the targets drop you'd know why business is so good in the industry these days. Lower right are cameramen Hettinger and Spencer. The last named gentleman took some lovely shots but writes that he hasn't had time to develop them.

starting from the outside edge of the glass beyond the iron support.

Sheets up to 12″ diameter and 12″ square were tested. It was found that the apparent strength increased as the size of the sheet increased indicating that most of the breaks except those over the small holes were due to vibrations of the sheet rather than to concentrated stresses at the point of impact. Samples showing the types of breakage produced were shown.

A series of slides recording the height to which a small steel ball was thrown by the vibration set up in a sheet of glass by the impact of a steel ball were shown. It was demonstrated that a very complicated wave pattern of exceedingly small high velocity waves is set up in the sheet. The apparent velocity of these waves varied greatly over distances as small as one-eighth inch along the surface. They also tended to focus at certain points in the sheet if the impact was off center.

It was concluded that impact tests of the type used are valueless unless the sheets are very large, the edge conditions are constant and all of the other factors are exactly duplicated.

Note: Unfortunately for our readers the remarks made extemporaneously by Mr. Bailey during the presentation of this paper have been omitted from the summary.—The Editor.

Progress Report on the Tensile Strength of Glass, *By W. B. Silverman and W. L. Schwalbe.*

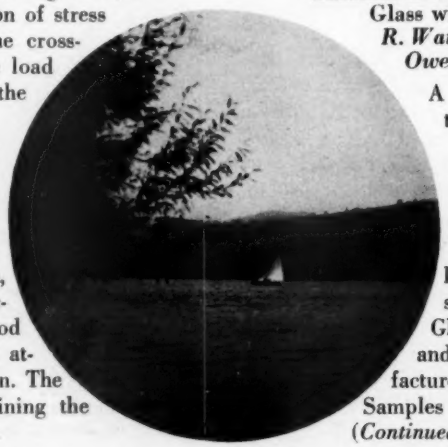
Experimental work by various investigators on the tensile strength of glass has yielded values which vary as much as 75 per cent from the maximum value. Cause for such discrepancies are:

1. The brittle nature of glass.
2. The relation between the rate of development of stress and the tensile strength.
3. The effect of the thickness of the specimens used.
4. Imperfections of loading systems.
5. The imperfections of the glass surface.

When the direct method for determining the tensile strength is used, it has been noted that the fractured surface is composed essentially of two parts; a smooth, reflecting area, and a deeply grooved rough appearing area. A review of the literature on the significance of such fractures, the effect of acid polishing the specimens, and the effect of thin fibres was presented.

A theoretical discussion of the distribution of stress in the specimen when under load was given and showed that the varying distribution of stress is the result of the action on the cross-section of the direct stress of the load and a bending moment due to the eccentricity. This was also deducted from the principals of mechanics.

As it is doubtful whether the action line or the applied load passes through the centroid of the area in the usual sort of apparatus, in the present investigation the design of the apparatus and the method of preparing the specimens is an attempt to approach such a condition. The apparatus and method of determining the tensile strength was described.



It was concluded: 1. The cause of the variation of the tensile strength with the type of fracture has not been satisfactorily explained, but it is apparently tied up in some manner with the eccentricity. 2. Since acid etching does not change the structure of the composition of the glass, it would be best to study the effect of composition on the tensile strength of glass by removing the fire-polished surface. In this way the surfaces of all specimens are reduced to a condition which will not vary a great deal from one specimen to another.

The Influence of Various Heating and Cooling Media on the Severity of Thermal Shock on Glass, *By R. G. Hunter, Owens-Illinois Glass Co.*

In order to determine the severity of thermal shock in its relation to the various substances employed in heating and cooling the glass, the following liquids were used: water, glycerine, ethylene glycol, and two oils of different viscosity. Additional tests were made from hot air to cold water and hot air to cold air. The protective action of the hot liquid film adhering to the surface of the sample was checked by comparing the relative severity of the two oils of different viscosities but having the same thermal properties.

The test method was as follows: ¾ oz. round bottles were used as specimens and 25 were used in each determination. A total of 150 bottles were used in each test. The bottles were heated at a predetermined temperature for 10 min. in a hot bath which was stirred. After equilibrium was reached the bottles were removed and plunged into a cold bath kept at constant temperature. The temperature differential was increased until a 50 per cent breakage level was reached. In the hot air tests the bottles were heated in an electric oven for one hour. The results are given in Table I.

TABLE I

Media	Temp. °F Required to Break 50 % of the Ware
Water	120
Hot air	136
Ethyteveglycol	237
Glycerine	242
No. 1 oil (low viscosity)	311
No. 2 oil (high viscosity)	336

Thermal Endurance of Different Types of Flat Glass with Relation to Thickness, *By W. R. Wampler and G. B. Watkins, Libbey-Owens-Ford Glass Co.*

A search of the literature on the thermal endurance of flat glass reveals little published material. This is due to the fact that such information in the past has not been required. The increasing need for such information in relation to newer uses of flat glass instigated the present study.

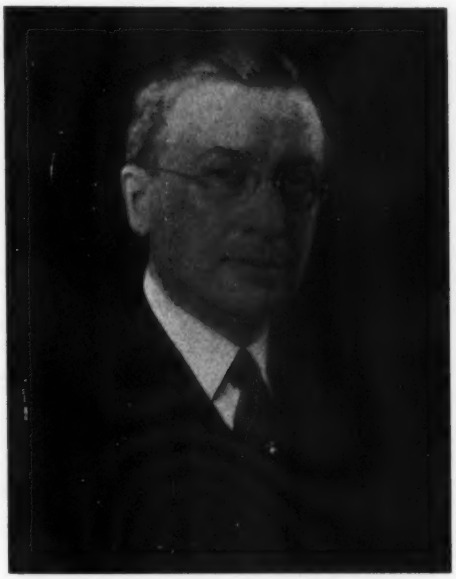
Glass squares measuring 3″ by 3″ and representative of glass as manufactured were taken as test samples. Samples thicker than 3/16″ were heated in

(*Continued on Page* 323)

GLASS ENEMY NO. 1

By ALEXANDER SILVERMAN

THERE has been considerable comment in recent years in technical journals, trade journals, and in the public press concerning the lack of protection which the present Tariff Act affords the glass industry; also, about the tendency of certain foreign manufacturers to imitate American ware and, through cheap labor, dump this on the American market at prices below those at which our ware can be manufactured. The writer realizes that certain governments actually subsidize their industries to enable them to export at very low prices. As stated, these topics have been covered by others and so the present article will confine itself to the subject of false invoicing, false entering, and improper classification, with possible methods for overcoming these.



Alexander Silverman, Head of the Department of Chemistry, University of Pittsburgh.

Let it be clearly understood that the writer is not accusing all importers of dishonest practice; for though our Tariff Act may not afford sufficient protection; many, if not the majority, of our importers conscientiously observe the intent of the Act as it stands. The comments made in this article apply to the minority group who have a tendency to resort to questionable practices.

The Tariff Act of 1930. Public Law No. 361 (H.R. 2667) was enacted June 17, 1930, and is known as the Tariff Act of 1930. It contains four titles: Title I, Dutiable List; Title II, Free List; Title III, Special Provisions; Title IV, Administrative Provisions. Under Title I, Dutiable List, there are various Schedules. Schedule 2 covers earths, earthenware and glassware, and contains paragraphs 201 to 236, inclusive, with their various sub-paragraphs. Paragraphs 217 to 231, inclusive, with their sub-paragraphs cover glass and enamels.

Under Title II, Free List, Paragraphs 1807 to 1812, inclusive, cover the duty-free importation of works of art under various classifications; namely, temporary exhibition, presentation to museums or art galleries, importation for private use and importation for sale.

Though generally clear, some of the paragraphs and their subdivisions are so worded that they might be susceptible of dual interpretation.

Procedure. Before taking up the procedure which is followed when an importer declares a shipment which has been received, the writer wishes to make it clear that he is not considering fraudulent billing of shipment. By fraudulent billing is meant the fact that an importer has made a partial payment on his purchase abroad and the foreign exporter bills the article purchased so that it enters at a lower price than the normal market price in the particular country of export. This sort of practice should readily be detected by the U. S. Customs Appraisers. The other practice to which specific attention will be given; namely, the false entry and classification of imported articles, is not so readily detected in all cases.

The importer makes an entry, designating the rate of duty and the paragraph under which he claims the merchandise is dutiable. This is classified by the Collector of the Port after the merchandise has been examined by a government appraiser. If the Collector finds the merchandise dutiable at a different rate and under a different paragraph than that claimed, the importer may, if he wishes, file a protest against the classification, or an amended protest, therein making the claim that the merchandise is improperly classified and that it is properly dutiable at a lower rate of duty, specifying the duty and the particular paragraph or sub-paragraph under which he claims the right of importation. This he has a perfect right to do. When the case comes up for a hearing, the burden of the proof is upon the importer, who must show by proper testimony that the Collector is wrong and that he (the importer) is right.

After the importer has made his entry and filed his protest, it may be a year and in some cases several years before the case comes up for a hearing. His attorney or broker will not push the case for trial if only a small amount is involved. He will generally wait until quite a number of cases of similar type have accumulated, these involving a considerable sum. He will then bring one case up for a hearing and withhold the others, pending the outcome of the first case. Should he lose, he or one of the other importers will try another protest, injecting a new theory of law.

Occasionally the Government or an American manufacturer or even a group of manufacturers may provide technical or trade witnesses to support the Government in its contention that the article imported should be placed under a classification calling for a higher import duty. Some importers are constantly on the alert to learn what is being planned and if they find that such evidence is being piled up against them, they will fail to appear in the U. S. Customs Court. Abandoning their cases and signifying acquiescence to the classification made by the Collector leaves the way open for subsequent attempts on their part or the part of other importers to bring a case in under other paragraphs and at a lower rate of duty. In other words, there is no record in the Customs Court of a decision and

judgment against them. The writer has just such a case in mind in which he was asked to testify recently, together with other technical and trade witnesses. The importer did not show up, the technical witnesses were not heard, the government classification stood. This sort of procedure on the part of the unscrupulous importer is discouraging to both the Government and the manufacturers.

As the result of such procrastination, merchandise is constantly being imported and cases are piling up to such an extent that continued or suspended cases or both will at times number several thousand, with an aggregate involving several hundred thousand dollars or perhaps even some millions, depending upon the class of merchandise imported. In January of 1935, approximately two hundred thousand cases were pending before the U. S. Customs Court awaiting final disposition. Consequently, when the calendar is made up, thousands of cases must be put on the docket, and there have been instances when as many as fifteen thousand cases were set for hearing in a single week and had to be disposed of in that time.

So much for the magnitude of the accumulation. Government attorneys having as little as ten days, and in some instances even less than five days to prepare for a trial, are confronted with insuperable difficulties when one considers the great number of diversified subjects and questions of law and fact which are involved. It is obvious that an attorney for the Government cannot do justice to the cases involved. We should bear in mind further that a U. S. attorney does not necessarily confine his attention to a single Schedule of the Tariff Act, like Schedule 2, previously referred to. This Schedule in itself is so varied that it requires an enormously diversified knowledge for proper interpretation to cover earths, earthenware and glassware.

Interpretation of the Tariff Act

Let us now consider a few cases which resulted in questionable decisions, owing to obscure provisions of the Tariff Act or to its imprudent and ambiguous drafting.

I. Fresnel Lenses. Imported merchandise was described on invoices as "lighthouse lenses"—"bull's eye and annular prisms"—"glass rings . . . . . floodlight lenses"—"lighthouse lenses . . . . . " complete with frames. These lenses are called "Fresnel lenses" and consist of two types, namely, "bull's eye" and "drum." They are intended for use in lighthouses and in aviation fields.

The above were classified and assessed for duty by the Collector as articles of glass used in connection with artificial illumination, composed wholly or in chief value of glass, dutiable at 60 per cent ad valorem under Paragraph 218 (c) of the Tariff Act of 1930. The importer claimed the merchandise dutiable at 10 cents per dozen pairs and 35 per cent ad valorem under Paragraph 226 of the 1930 Act.

The pertinent parts of the competing Paragraphs read as follows: Par. 218 (c). Illuminating articles of *every* description, finished or unfinished, wholly or in chief value of glass, for use in connection with artificial illumination: Prisms, glass chandeliers, and articles in chief value of prisms . . . . . ; chimneys . . . . . , globes and shades . . . . . ; *all others* 60 per centum ad valorem: *Provided*, That parts not specially provided for, wholly or in chief value of glass, of any of the foregoing shall be subject to the same rate of duty as the articles of which they are parts.

Par. 226. Lenses of glass or pebble, molded or pressed, or ground and polished to a spherical, cylindrical, or prismatic form, and ground and polished plano or coquille glasses, wholly or partly manufactured . . . . . with edges ground or beveled, 10 cents per dozen pairs and 35 per centum ad valorem; . . . . .

The lenses provided for under Paragraph 226 are lenses used in spectacles and eye glasses and in optical instruments and optical goods for scientific, professional and other purposes. Although Fresnel lenses are used to indicate location and direction for navigators and aviators and provide floodlights for the landing aviators, the Court held them dutiable under Paragraph 226 at 10 cents per dozen pairs and 35 per cent ad valorem and not as articles of glass "for use in connection with artificial illumination."

It is obvious that a considerable saving is effected as the result of this decision on lenses which are unquestionably employed for artificial illumination and should have been assessed at 60 per cent ad valorem.

II. X-Ray Lead Glass. This merchandise consisted of heavy glass about a quarter of an inch thick with a yellow tinge and a high lead content. It had been cut to definite and specified sizes for specific uses and was invoiced as "———— brand X-ray lead glass." The Collector classified and assessed duty at 50 per cent ad valorem under Paragraph 230 (d) of the Tariff Act of 1930 which reads:

"All glass, and manufactures of glass, or of which glass is the component of chief value, ... not specially provided for, 50 per centum ad valorem."

The importer protested the classification and claimed the glass as properly dutiable under Paragraph 222 (a) of the 1930 Act, which follows:

"Par. 222 (a). Plate glass, by whatever process made, not exceeding three hundred and eighty-four square inches, 12½ cents per square foot; above that and not exceeding seven hundred and twenty square inches, 17 cents per square foot; above that, and not exceeding one thousand and eight square inches 17½ cents per square foot; all above that, 19¾ cents per square foot: *Provided*, That none of the foregoing measuring one-half inch or over in thickness shall be subject to a less rate of duty than 50 per centum ad valorem."

Sub-paragraph (b) provides for "Plate glass containing a wire netting within itself, ... and after this, sub-paragraph (c) defines "Plate Glass" as "glass wholly ground and polished on both surfaces."

As the glass in question was intended for use only for surgical and scientific purposes, as a protection against injurious radiations, the Government further claimed that if not dutiable under Paragraph 230 (d), it should be held dutiable under Paragraph 218 (a) "as glass dedicated for surgical and scientific purposes for which plate glass cannot be used." This Paragraph reads:

"Par. 218 (a). Biological, chemical, metallurgical, pharmaceutical, and surgical articles and utensils of all kinds, including all scientific articles and utensils, whether used for experimental purposes in hospitals, laboratories, schools

or universities, colleges, or otherwise, all the foregoing (except articles provided for in Paragraph 217 or in subparagraph (e), finished or unfinished, wholly or in chief value of glass, 85 per centum ad valorem;"

Because subdivision (c) of Paragraph 222 defines "plate glass" as previously stated, the Customs Court held the X-ray lead glass dutiable as "plate glass" with the consequence that instead of coming in under Paragraph 218, with a duty of 85 per cent ad valorem, it was held to be dutiable under Paragraph 222 at a duty of 12½ to 19¾ cents per square foot, depending on the size of the plates, for it was less than half an inch thick. It would seem that X-ray lead glass should have been held dutiable under Paragraph 218 at 85 per cent ad valorem.

III. Optical Glass. This is provided for in Paragraph 227 of the Tariff Act of 1930 as follows:

"Optical glass or glass used in the manufacture of lenses or prisms for spectacles, or for optical instruments or equipment, or for optical parts, scientific or commercial, in any and all forms, 50 per centum ad valorem."

On the other hand, optical glass about a quarter of an inch thick, cut into circles called "blanks" and also "discs", from which lenses are made was held properly dutiable under Paragraph 226, which follows:

"Par. 226. Lenses of glass or pebble, molded or pressed, or ground and polished to a spherical, cylindrical, or prismatic form, and ground and polished plano or coquille glasses, wholly or partly manufactured, with edges unground, 40 per centum ad valorem; with edges ground or beveled, 10 cents per dozen pairs and 35 per centum ad valorem . . . . . "

The U. S. Customs Court held that glass cut into a circle which was later to be ground and polished as a lens constituted a "partly manufactured lens," dutiable under Paragraph 226 at a lower rate of duty than the glass (optical) out of which the lens is made (Par. 227.).

Now a "blank" or "disc" is a "form" of glass out of which a lens is intended to be made, and not necessarily a type of lens. In order to make a lens out of a "blank" or "disc" it is necessary that both surfaces be ground and polished. If only one surface is ground and polished, and this permits the character of the glass to be determined, it is still only a partly manufactured lens.

A "blank" or "disc" is essentially optical glass, out of which a lens is to be made, and would seemingly be dutiable at 50 per cent ad valorem under Paragraph 227 and not at the lower rates indicated in Paragraph 226. Why should a partially or wholly manufactured lens be dutiable at a lower rate of duty than the glass or material from which such a lens is made?

IV. Goggles. In this case, which involved sheet glass cut into circles and other irregular shapes used in goggles for protecting factory workers and aviators, the importer claimed the article as dutiable under Paragraph 219 as "cylinder, crown and sheet glass by whatever process made and for whatever purpose used, unpolished, not exceeding 150 square inches." The Collector classified the articles under Paragraph 227 as "optical glass used in the manufacture of lenses."

At the trial of the issue before the U. S. Customs Court, Government Counsel contended that Paragraph 230 of the Tariff Act of 1930, rather than Paragraph 227, correctly described the merchandise and that the Court should find the merchandise to be properly dutiable under Paragraph 230, and therefore overrule the protest without affirming the action of the Collector. The pertinent part of Paragraph 230 reads: "All glass or manufactures of glass, ... not specially provided for, 50 per centum ad valorem."

The U. S. Customs Court, however, sustained the importer in his protest and held that "the merchandise in question was dutiable as claimed under Paragraph 219, at 1⅞ cents per pound." On appeal, the U. S. Court of Customs and Patent Appeals in reversing the Court below and sustaining the Government said:

"The samples, however, show the goods to be something more than plain glass. They have been subjected to a manufacturing process. They have been dedicated, insofar as the record goes, to a single use and have no other use than in the making of goggles. The decision of this case is plainly controlled by our judgment in Konishi Kotakudo Co. v. United States, 17 C.C.P.A. (Customs) 255.T.D.43798. In that case the imported merchandise was glass blanks, small pieces of glass, cut into various forms and intended to be used for watch crystals and similar articles. The majority of the Court held that each of the articles was dedicated to a single use and that, hence, each was a manufacture of glass, under said Paragraph 230. Judges Bland and Lenroot, while disagreeing with the majority in its views on the single use doctrine, concurred in the conclusion upon the theory that each article has been processed from the raw material to a point where it has a distinctive character, name, or use different from that possessed by the original material, and that having undergone such processing, it is immaterial that someone finds more than one use for it.

"Plainly, under either the views of the majority or of the special concurring minority in that case, the articles now before us are manufactures of glass * * * * * Our view, therefore, is that the Court below erred in sustaining appellee's claim under said Paragraph 219, and that the imported goods were properly classified under said Paragraph 230, unless more specially provided for in some other paragraph of the Act, not put in issue here."

V. Circular Pieces of Glass with Beveled Edges. The case involved discussion of glass cut to definite size and shape for use in typewriter keys. The Collector classified and assessed them as dutiable under Paragraph 230 (d) of the Act of 1930. The importer protested the classification and claimed the merchandise dutiable under Paragraphs 219 and 224 at 1⅞ cents per pound, plus 5 per cent ad valorem. Pertinent parts of competing paragraphs follow:

"Par. 230 (d). All glass, and manufactures of glass, or of which glass is the component of chief value, ... not specially provided for, 50 per centum ad valorem.

"Par. 219. Cylinder, crown, and sheet glass, by whatever process made, and for whatever purpose used, not exceeding one hundred and fifty square inches, 1⅞ cents per pound; . . . . .

"Par. 224. Plate, rolled, cylinder, crown, and sheet glass, and glass mirrors exceeding in size one hundred and forty-four square inches, by whatever process made, when bent, frosted, sanded, enameled, *beveled*, etched, embossed, engraved, flashed, stained, colored (except glass not plate glass and not less than one-fourth of one inch in thickness, when obscured by coloring prior to solidification), painted, ornamented, or decorated, shall be subject to a duty of 5 per centum ad valorem in addition to the rates otherwise chargeable thereon."

Consequently, these discs which are not only used in typewriter keys but in cash registers, adding machines, vending machines, etc., and which constitute "manufac-

tures of glass" under Paragraph 230 dutiable at 50 per cent ad valorem, were, because they were not dedicated to a single use, and also through the Government's lack of witnesses, held dutiable as sheet glass at 1⅞ cents per pound under Paragraph 219, plus 5 per cent ad valorem for the beveled edges, the latter covered under Par. 224.

VI. GLASS RODS. Under the old Tariff Act of 1922, glass rods were provided for in two paragraphs which follow:

"Par. 218. Biological, chemical, metallurgical, pharmaceutical, and surgical articles and utensils of all kinds, including all scientific articles, utensils, *tubing and rods*, whether used for experimental purposes in hospitals, laboratories, schools or universities, colleges *or otherwise*, ... "

"Par. 231. Smalts, frostings, and all ceramic and glass colors, fluxes, glazes, and enamels, all the foregoing, ground or pulverized, 30 per centum ad valorem; *in any other form*, 40 per centum ad valorem; opal, enamel or cylinder glass tiles, tiling, *and rods*, 40 per centum ad valorem."

In the 1930 Act, tubes and rods are covered by sub-paragraph (b) of Paragraph 218, which follows:

"Par. (b). Tubes (except gauge glass tubes), *rods*, canes, and tubing, with ends finished or unfinished, for whatever purpose used, wholly or in chief value of glass, 65 per centum ad valorem; wholly or in chief value of fused quartz or fused silica, 40 per centum ad valorem; . . . . . "

Paragraph 231 of the Act of 1930 reads the same as the corresponding paragraph of 1922 with the exception that the words "and rods" have been omitted. This has been done deliberately in the belief that rods would not be dutiable under Paragraph 231.

Now the question arises: Are glass rods composed of soft enamel glass with ends finished or unfinished, which rods are at times used for enameling purposes, dutiable at 65 per cent under sub-paragraph (b) of Paragraph 218, or are they dutiable under Paragraph 231 as enamel in any form, provided for in said Paragraph 231 at 40 per cent ad valorem?

VII. BOTTLES. Paragraph 217 of the Tariff Act of 1930, provides:

"Par. 217. Bottles, vials, jars, ampoules, and covered or uncovered demijohns, and carboys, any of the foregoing, wholly or in chief value of glass, filled or unfilled, not specially provided for, and whether their contents be dutiable or free (except such as contain merchandise subject to an ad valorem rate of duty, or to a rate of duty based in whole or in part upon the value thereof, which shall be dutiable at the rate applicable to their contents), shall be subject to a duty as follows: If holding more than one pint, 1 cent per pound; if holding not more than one pint and not less than one fourth of one pint, 1½ cents per pound; if holding less than one fourth of one pint, 50 cents per gross: PROVIDED, That the terms 'bottles', 'vials', 'jars', 'ampoules', 'demijohns', and 'carboys', as used herein, shall be restricted to such articles when suitable for use and of the character ordinarily employed for the holding or transportation of merchandise, and not as appliances or implements in chemical or other operations, and shall not include bottles for table service and thermostatic bottles."

Paragraph 217, in the Acts of 1909, 1913, 1922 and 1930, are substantially the same. They all contain the restrictive clause.

The United States Customs Court has repeatedly held that "bottles", "jars", etc., imported empty and sold empty, even high grade bottles ranging in price from 15 to 35 dollars each, which are never sold with any contents, were dutiable under Paragraph 217, according to size.

When one considers that all bottles are naturally manufactured to receive contents, it would seem that by the restricting clause the Congress recognized the fact that some "bottles," "jars," etc., "were not *suitable or of the character ordinarily employed for the holding or transportation of merchandise,*" such as boudoir bottles, jars, etc., which are only filled by the purchasers after purchasing, with toilet preparations, etc., according to their wants or liking; otherwise, all "bottles", etc., would appear to be subject to Paragraph 217, and the restricting clause would be meaningless.

Under Title IV. Administrative Provisions, Sec. 401. Miscellaneous, of the Tariff Act of 1930, the word "merchandise" is defined as follows:

"When used in this title or in Part 1 of Title III- * * * * * (c) MERCHANDISE.—The word 'merchandise' means goods, wares, and chattels of every description and includes merchandise the importation of which is prohibited."

A similar definition is found in Section 401 of the Tariff Act of 1922. The definition, however, is limited to Title IV.

When one further considers that articles purchased in the United States by individuals who intend them for personal use only and not for sale, such as perfumes, cosmetics, etc., are commercially designated as personal property, it becomes evident that the above definition of "merchandise" is applicable only to articles which are about to be entered and assessed for duty by the Collector, and that it does not contemplate other articles not subject to tariff law.

In holding "bottles", "jars", etc., which are imported empty, and sold empty, both in the wholesale and retail trade, and which are not "suitable and of the character ordinarily employed for the holding or transportation of merchandise," dutiable under Paragraph 217, the United States Government has lost many hundreds of thousands of dollars in revenue. This tendency has at the same time seriously affected American Industries manufacturing articles of like character sold in competition with the imported articles.

VIII. MISCELLANEOUS. There are many paragraphs in the Tariff Act of 1930 which do not relate to glass alone or to fabricated articles in which glass is employed in part. Owing to the wording of the various paragraphs in the Tariff Act, it is sometimes exceedingly difficult to classify such articles properly and when one considers that the Government employees are not necessarily expert in all fields, he can readily see problems which might arise in classifying scientific instruments as articles which are in more common commercial use. For example, optical measuring or optical testing instruments might come in under Paragraph 228 of Schedule 2. Again, they might be considered under Paragraph 353 or 360 of Schedule 2, which cover metals and manufactures of metals. The Customs Court is inclined to rely upon an old definition given in a case which dates back many years, in which an optical instrument is defined as:

" . . . . . something to be used as an aid to sight or the eye . . . . . an optical instrument is related in some manner to

the science of optics and is peculiarly and especially related to vision—to doing something to protect or assist in more perfect sight. . . . . Certainly to the layman an optical instrument would seem to be one used to assist the eye or an instrument pertaining to the sight and laws of vision."

This old interpretation does not take into account the advances that have been made in optical measuring or optical testing instruments, involving physical optics during and since the World War. In a sense, there should be a distinction between physical optics and physiological optics or, in other words, between an instrument used for a scientific purpose and the more common devices used to correct the vision (whether in normal observation or in special types required in the trade, such as magnifying lenses, etc.)

Summary Recommendations and Conclusions

We have considered eight examples which are controversial from the standpoint of the type of importer discussed in this article and U. S. Government officials. What has been said of "lighthouse lenses", "X-ray glasses", "optical glass", "goggle glass", "typewriter discs", "glass rods", "fancy bottles" and "optical instruments" might in a similar way apply to many other types of imported glass, and other articles, not made of glass. It is obvious that with the piling up of cases and the natural limits of knowledge of the number of employees which the Government is able to employ for Customs purposes, some step is necessary on the part of American manufacturers if they wish to protect the Government and themselves in connection with the vast sums of money involved. The slackness and incongruities of the tariff laws, it would seem, could have been easily rectified had the American Industries been properly represented at the time of the drafting of the Tariff Act.

To remedy this situation, it is necessary for the manufacturers through their associates or through an entirely new organization to go a step beyond their present efforts of tariff revision. They could, in the estimation of the writer, remedy the situation in the following ways:

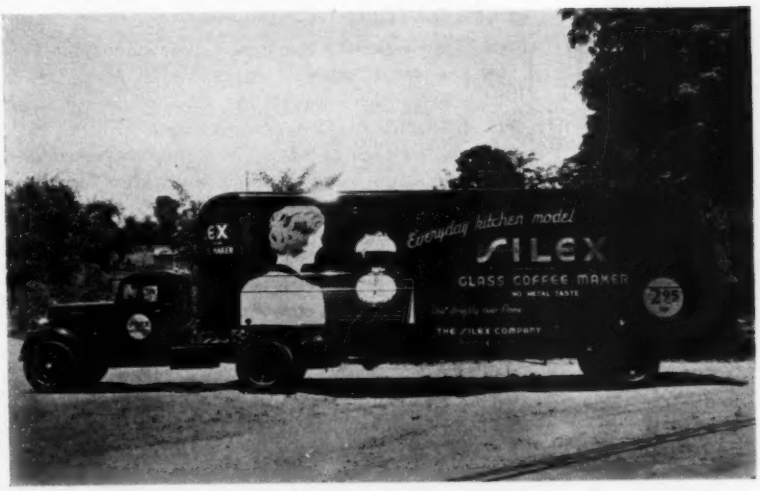
1. By furnishing to the United States Government, at the companies' expense or at the expense of an association of manufacturers, under the supervision of competent counsel, expert witnesses who would assist the Collector of the Port in properly classifying articles which are imported and in helping the United States attorneys to prosecute cases in which improper classification is claimed by the importers.

2. It should be possible for an association of manufacturers so to pool their interests as to create a considerable subsidy for the employment of experienced members of the bar, *versed not only in the technicalities of the Customs law, but also possessing a commercial, as well as mechanical and scientific mind and training, together with* technical men, whose business it would be to look into and follow up cases *before trial for the purpose of aiding the Government Attorney*, thus preventing a *miscarriage of justice* against the Government and serious competition with American industry. A *capable* individual or individuals *possessing the above qualifications and* conversant with government problems or even experienced in the service itself should be available.

Vast sums of money are lost annually by the United States Government through improper classification of imported articles in the glass field as well as in other fields. The Tariff itself is regulated by law and subject to amendment if the representatives of the American people in Washington are duly impressed by manufacturers and the populace at large; in other words, by those who create industry and those who derive a livelihood from it. This then is a problem for the manufacturer and the people, for the Tariff is a matter of government regulation.

The false invoicing and entering of imported ware, whether in glass or in other material, is a commercial fraud in that it involves a theft from the Government and creates a dishonest competition with American industry. The individual guilty of such an act is a public enemy and in the glass field might well be classed as "Glass Enemy No. 1." Everything that is possible should be done to bring the violator of the law to justice.

[1] Contribution No. 299 from the Department of Chemistry, University of Pittsburgh.



The new "moving billboard" of the Silex Company, Hartford, Conn. Twice each week, this 39 ft. truck plies its regular schedule between Hartford and Corning, N. Y. Its decoration is so striking as to catch and hold the attention of even the most casual observer. A basic black color, with the rear in gold leaf, on which is outlined a silver coffee maker.

CONCERNING TUCKSTONES*

By JOSEPH EARLY
Amsler-Morton Company

THE connections in Group 4 are used in the melting end and consist of those in which various types of refractory shapes are used for tuckstones. In all cases the tuckstone is set back from the inside edge of the Flux block.

GROUP 4—*Tuckstones Set Back from the Inside Edge of the Flux Block.*

(a). This connection does not fulfill the major requirement. It is accessible for cooling and hot repairs and the tuckstone is adequately tied in to the silica sidewall so that tipping due to erosion of the flux block is prevented. Partial protection of the flux block tops only is afforded and is undesirable. The construction is simple but more expensive than those in Group 3 as the standard refractory shapes used are larger and therefore more expensive. As the connection does not meet the major requirement it is not recommended.

(b). This is an older type of construction and as in most old types there is adequate provision for support of the silica sidewalls during re-blocking. It is easily accessible for cooling and hot repairs. The tops of the flux blocks are well protected but if the tops of the blocks recede through erosion there is a danger of the tuckstone toppling over. The connection is simple, standard shapes only being used. While this connection has possibly been used with success it is not to be recommended due to the danger of losing the tuckstone.

(c). This construction is similar to (b) except that a six inch tuckstone has been substituted for the eight inch size and in addition a nine inch block has been placed upon it. The major requirement is met but the structural support is such that the accessibility for cooling and hot repairs is reduced. The protection from erosion is only partial. The use of standard materials makes the construction simple, although the reason for the use of nine inch block is subject to conjecture; possibly it was added to lessen the heat losses through the connection. The construction is subject to the same criticism as (b) as there is still a danger of losing the tuckstone and the extra block sitting on the tuckstone. The joint between the silica sidewall and the refractory block is also bad because, as in all such connections, the clay fluxes out of the silica brickwork. While this connection adequately supports the silica sidewall the danger of losing the tuckstone and the extra block prevents the recommendation of this type of construction.

(d). This is similar to the two foregoing types, except that a clay block has been used back of the tuckstone as a support for the silica sidewall during re-blocking. Also disclosed is another possible arrangement of the structural supports. The addition of the channel was possibly due to an exceptionally wide spacing of the buckstays. The major requirement of silica sidewall support is adequately fulfilled by this connection, but the accessibility for cooling air and hot repairs is even less than in the preceding construction. The protection is the same as the others in this group, but as this tuckstone has more lap under the sidewall, there is less possibility of its toppling into the tank as the top of the flux block becomes eroded. The construction is simple in that only standard materials are used, and while the construction has some merit, it is not to be recommended as an ideal type.

(e). This is another of the old standbys (with many possible minor dimensional variations in the tuckstone), and makes adequate provision for the support of the silica sidewalls during re-blocking. An angle casting is used for silica sidewall support, which reduces the desired accessibility for cooling and for hot repairs to a marked degree. The shape of the tuckstone with the tongue under the silica sidewall is such that there is little possibility of its toppling into the tank thru flux block erosion, but is subject to the criticism of lack of protection, as the tops of the flux blocks are only partially covered. This connection is simple in that the shape shown has been so extensively that it may be obtained from all the refractory manufacturers. The casting used for support would add to the initial cost. The vertical joint between the silica brickwork and the clay is bad because of the fluxing action between the two materials. This connection has given good service but is not to be recommended for new construction.

(f). This is a refinement of the second preceding connection in that the supports have been raised to provide accessibility. The major requirement has been taken care of, accessibility for cooling and hot repairs is good, and the protection is the same as in all of this group; but the tuckstone is not tied sufficiently to prevent its toppling into the tank in case of erosion of the tops of the flux blocks. The thin section with the six inch brick over the tuckstone would be a source of heat loss and is so located behind the supporting structure that it would be impossible to make hot repairs in case of its toppling into the tank. Due to this fact, this type of construction is not recommended.

(g). This connection has a minimum amount of support for the silica sidewall during re-blocking, a six inch brick being the smallest that should be used. The six inch brick would also provide more protection to the tops of the flux blocks. The supporting structure shown in this sketch is an angle casting with a fin added for strength. This fin has decreased the accessibility for cooling and hot repairs. The casting also increases the initial cost while having little or no value. A casting was possibly introduced because on some previous job a steel angle has burned out as a result of a joint opening and permitting the fire to reach it. This casting is an expedient, and is not the proper change to make to correct the trouble. The correction is to alter the construction so that the fire couldn't reach the steel if some joint did open up.

It is not an entirely simple connection, and with its

*The second and concluding part of a discussion begun in the September Glass Industry.

other evident shortcomings, is not to be recommended.

(h). This is similar to connection (g) except that the supporting structure has been changed to a simpler design by the use of an angle instead of the casting, and the tuckstone has also been made into a special shape. No simplicity in the connection has been gained through these changes however. The same objection, i.e. lack of adequate support for the silica sidewall during the re-blocking, holds for this connection also. The change from the casting to the angle makes for accessibility for cooling and hot repairs. The protection provided for the tops of the flux blocks is not sufficient. This connection is not to be recommended in its present form, but if the brick supporting the silica sidewall in the angle were increased to six inches instead of four and one half, thus providing the necessary support and also furnishing more protection for the tops of the flux blocks, this connection would be improved.

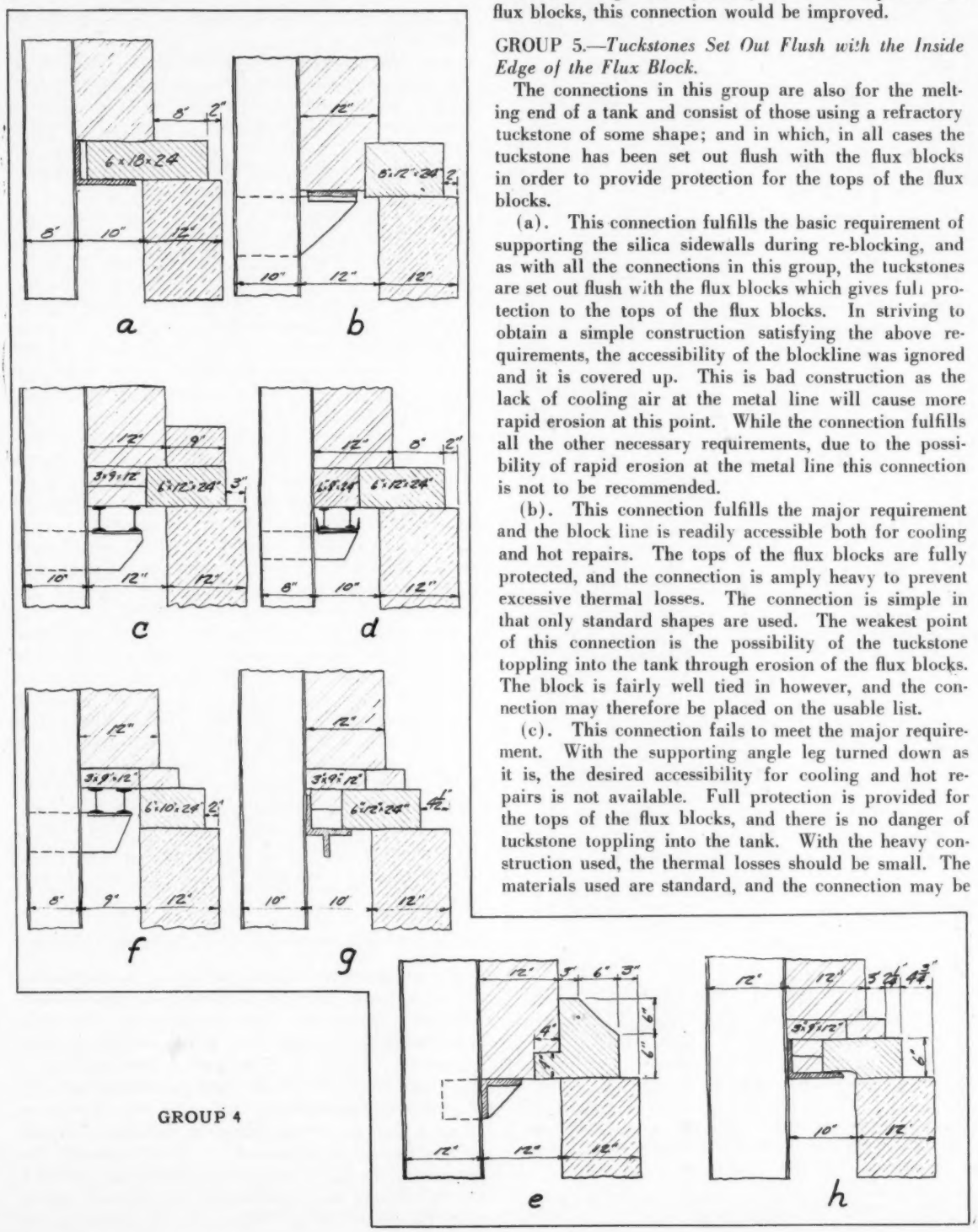
GROUP 5.—*Tuckstones Set Out Flush with the Inside Edge of the Flux Block.*

The connections in this group are also for the melting end of a tank and consist of those using a refractory tuckstone of some shape; and in which, in all cases the tuckstone has been set out flush with the flux blocks in order to provide protection for the tops of the flux blocks.

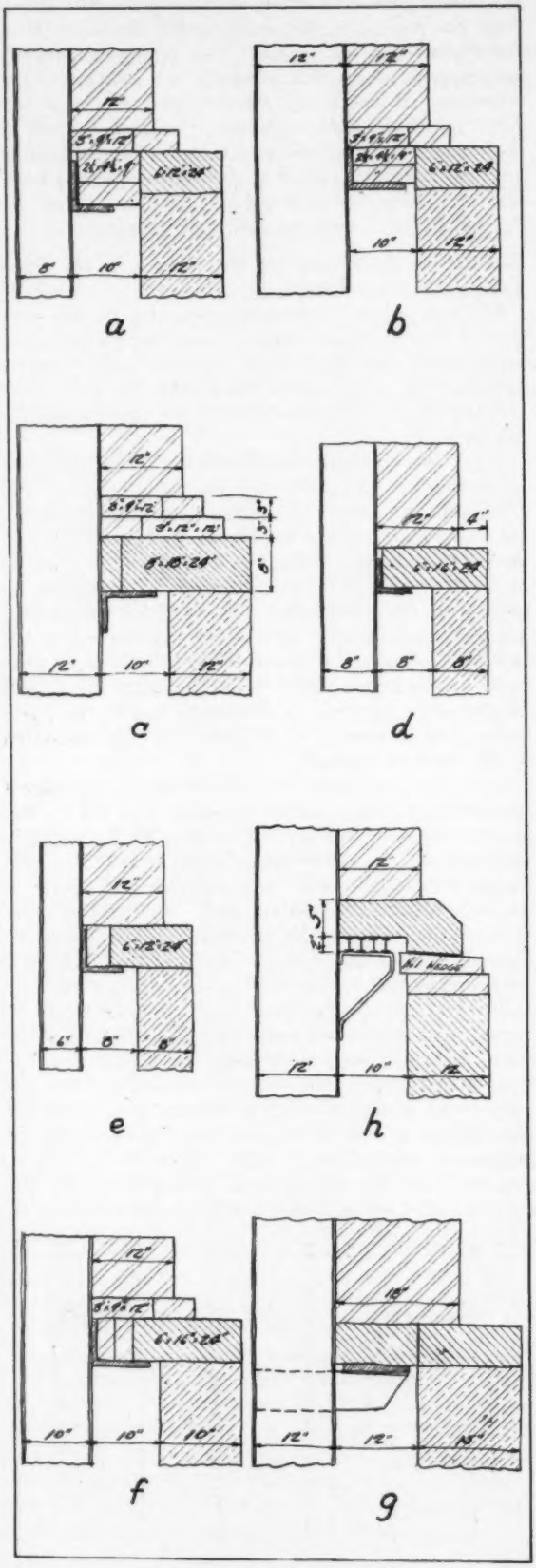
(a). This connection fulfills the basic requirement of supporting the silica sidewalls during re-blocking, and as with all the connections in this group, the tuckstones are set out flush with the flux blocks which gives full protection to the tops of the flux blocks. In striving to obtain a simple construction satisfying the above requirements, the accessibility of the blockline was ignored and it is covered up. This is bad construction as the lack of cooling air at the metal line will cause more rapid erosion at this point. While the connection fulfills all the other necessary requirements, due to the possibility of rapid erosion at the metal line this connection is not to be recommended.

(b). This connection fulfills the major requirement and the block line is readily accessible both for cooling and hot repairs. The tops of the flux blocks are fully protected, and the connection is amply heavy to prevent excessive thermal losses. The connection is simple in that only standard shapes are used. The weakest point of this connection is the possibility of the tuckstone toppling into the tank through erosion of the flux blocks. The block is fairly well tied in however, and the connection may therefore be placed on the usable list.

(c). This connection fails to meet the major requirement. With the supporting angle leg turned down as it is, the desired accessibility for cooling and hot repairs is not available. Full protection is provided for the tops of the flux blocks, and there is no danger of tuckstone toppling into the tank. With the heavy construction used, the thermal losses should be small. The materials used are standard, and the connection may be



GROUP 4



GROUP 5

classed as simple. This connection, because of its failure to meet the major requirement, although being satisfactory in other respects, is not to be recommended.

(d). This connection fails to meet the major requirement. The tops of the flux blocks are accessible for cooling and hot repairs, and are adequately protected from erosion. With this construction there is no possibility of it toppling into the tank as the flux blocks are eroded but while this connection satisfies all except the major requirement it cannot be recommended because of that.

(e). This is similar to the foregoing connection except that an attempt has been made to provide some support for the silica sidewalls during re-blocking but the support is still inadequate. As in the preceding, the accessibility is satisfactory, protection is good, and simplicity is fulfilled but failing in the major requirement the connection is not recommended.

(f). This connection fulfills the major requirement. The accessibility of the block line for cooling and hot repairs is satisfactory. The flux blocks are given full protection and the connection is heavy enough to prevent large thermal losses. Being constructed of standard shapes the simplicity is satisfactory and there is enough lap on the tuckstone to prevent its toppling into the tank in case of erosion of the flux blocks at the metal line. This connection satisfies the requirements and can be placed on the usable list.

(g). This construction satisfies the major requirement. It is not accessible for cooling and hot repairs as much as may be desired. The tops of the flux blocks are well protected but the fifteen inch flux blocks are thicker than generally found in tank practice. The eighteen inch sidewall is also thicker than generally used but this thickness may become more general as the sidewalls heat losses through radiation are studied. The construction as shown is not recommended.

(h). This is a connection from a tank in Europe and is shown as one example of their practice. The major requirement is adequately taken care of, the tops of the flux blocks are well protected, and the connection is easily accessible for either cooling or hot repairs. One serious drawback is the possibility of the special shape cracking off and being lost before the silica sidewalls are in need of repairs. The connection is to be considered complicated in view of the additional work on the supporting structure and the special shape required. While the connection satisfies the requirements it is not to be recommended for standard practice because of these objections.

GROUP 6—*Tuckstones showing latest developments.*

This group of tuckstones is also used in the melting end of the tank. They are of more recent development and more complicated than the foregoing, but show more thought concerning the requirements of a suitable connection. Included in this group are connections which can be considered the best possible in the light of present day knowledge.

(a). This connection supports the silica sidewall entirely free of the flux blocks as do the others in this group, and the major requirement is entirely satisfied. The flux blocks are accessible for cooling and hot repairs, the tops of the flux blocks are fully protected and

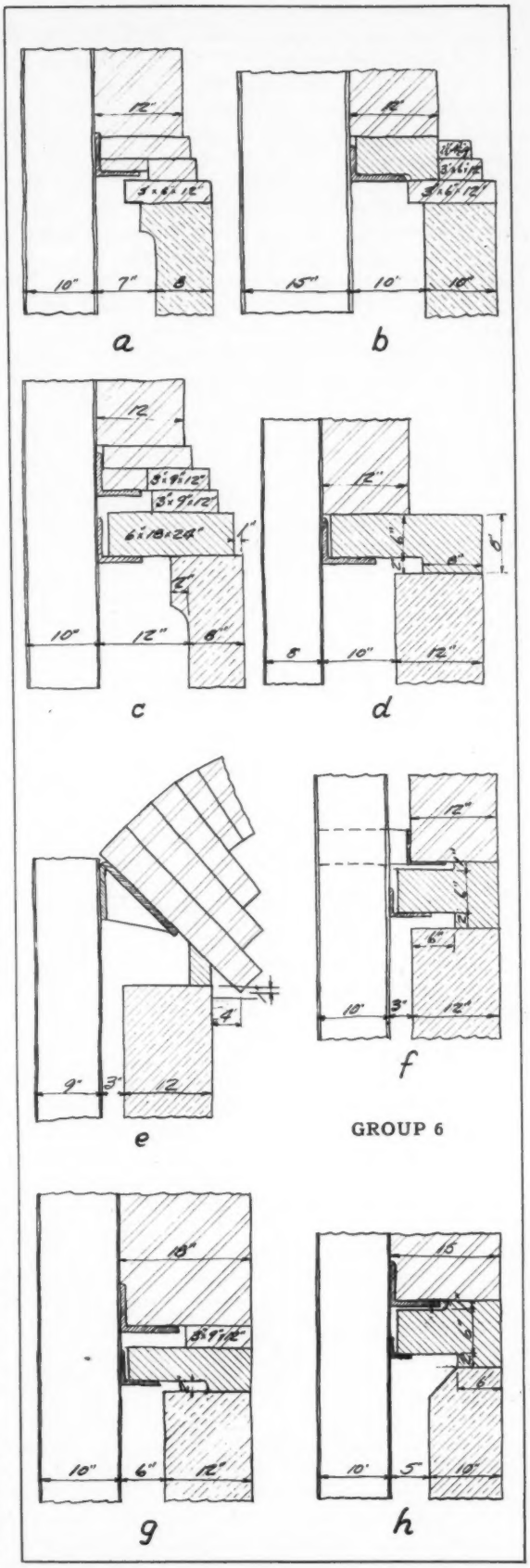
there is no danger of the silica bricks covering it toppling into the tank. All materials shown are standard and the design can be considered simple. This connection is on the usable list.

(b). This connection is similar to the preceding one but is not so simple that a special refractory shape has been used. The major requirement is satisfied. The tops of the blocks are easily accessible for cooling and hot repairs and the tops of the flux blocks are well protected. There is a possibility that the silica bricks forming the connection may topple into the tank as erosion eats back the tops of the flux blocks. This connection satisfies the major requirements, but due to the possible loss of the silica bricks into the tank it is not to be recommended. If super refractory blocks were used instead of ordinary flux blocks, this danger would be lessened.

(c). This connection is more complicated than (b) in that a separate angle is used to support the silica sidewall in order to satisfy the major requirement of support during re-blocking. Accessibility for cooling the block line and for hot repairs is provided. Ample protection is also provided for the tops of the flux blocks but the connection is complicated and would be expensive to construct. While the connection is good some slight changes should be made before it can be placed on the recommended list. These changes are: cutting the offset down to eight inches from the twelve shown; cutting the tuckstone down to six by fourteen by twenty-four inches; and making the supporting angle smaller.

(d). This connection does not fulfill the major requirement. The special shape used was made to provide access to the tops of the flux blocks for more efficient cooling and, of course, makes this point more accessible for hot repairs. The tops of the flux blocks are also well protected. The connection is not simple in that the tuckstone is of special shape. If the construction used super refractories in which the life of the tuckstones and the blocks were about the same, it could be given more consideration. In its present form this connection is not recommended.

(e). This connection is discussed at this point because of its similarity to the ideal type of construction. The design was found (while searching the literature) in an old patent numbered 463,149, and was issued to Emile Gobbe in 1891. The design shows that an appreciation of the problems to be satisfied was early recognized. Quoting from the specifications of the patent, "The first layers of the arch, project over the glass bath so as to form between the surfaces of the glass and the arch a small open space which will not receive the radiation of the flame of the furnace and which may be cooled off by a current of air. By this arrangement . . . as it forms a shield which intercepts these rays and prevents them from reaching the walls of the tank which are subsequently constantly in contact with a glass scarcely pasty which will only slightly affect the refractory tile." This patent also disclosed the use of air cooling at the tops of the flux blocks for helping to preserve them. At the time there was great agitation for the water cooling of the flux blocks and a number of patents on such methods were issued. This patent also disclosed a thin section about twelve inches deep at the top which was to



be used for water cooling. Insofar as the flux blocks were almost entirely eroded at the top, the lower sections were set inside an iron plate and no provision made for cooling this portion. This is a very interesting point as it is a forerunner of the most recent trend in tuckstone construction. With such an early start it would seem that some further developments might have been made and the experiences of some of the "Old Timers" in the industry concerning designs of tuckstones and reasons for their failure should be enlightening.

This connection satisfies the major requirements. The tops of the blocks are accessible for cooling or hot repairs and are entirely shielded from the flame and from the corrosive action of the glass and batch fumes. This protection is due to the cooling of the flux blocks through the shielding of the extended block from the crown. An example of the influence of this type of construction is disclosed in Group 3 (a). It is possible that this design was discarded because of mechanical troubles and because of problems of furnace design. The extremely large pieces of silica doubtless cracked off exposing the supporting structure and necessitated the shutdown of the tank. With the design as shown, proper combustion volume could not be obtained under the crowns and was possibly another reason for its abandonment.

(f). This connection appeared in one of a series of sheets issued by the Findlay Clay Products Company during the past year.

This connection fulfills the major requirement. Excellent provision is made for cooling the tops of the flux blocks and increasing the life by lowering the temperature and holding the protective viscous skin on them in place. As this prevents erosion of the flux blocks the provision for hot repairs is not so essential. Because only one face of the tuckstone is exposed to the high flame temperature a super refractory material in the tuckstone, as has been the tendency in some factories, is not necessary. The connection is complicated in that two supporting angles are used in connection with a special refractory shape and further complications enter in providing flux block support against the outward thrust of the glass. As it satisfies the other requirements the connection is to be highly recommended.

(g). This is a variation of the preceding connection and shows the use of an eighteen inch silica sidewall instead of a twelve inch wall. As in the foregoing there is adequate provision for the sidewall support during re-blocking and the tops are accessible for the type of cooling that is desired for the flux block protection. There is some heat loss in keeping the temperature of the tops of the flux blocks below the erosion temperature, but this should be overcome through additional length of operation. The eighteen inch wall has a smaller loss from this source than the twelve inch silica sidewall and is one of the reasons for its inclusion. This construction provides a six inch offset which would give more room for flux block support. This connection is more expensive than (f) but it seems justifiable in view of the lessened heat loss. The connection is also highly recommended.

(h). This connection is of the same basic construction as the preceding, but the wall has been reduced to fifteen inches and the flux blocks to ten inches. The top of the block has also been cut back at forty five degrees in order to provide more accessibility to the tops of the blocks for more efficient cooling. There has appeared, from time to time, discussion as to cooling the flux blocks by spraying water on them, and this construction would be well adapted to this type of cooling. Cutting down the thickness of the tops of the flux blocks at this point rather than increasing them as is the accepted practice, is based entirely on the assumption that the thesis of proper cooling and its subsequent retention of the protective skin is correct. As in the preceding connections the major requirement of silica sidewall support is fulfilled, the cooling is sufficient, no hot repairs are assumed to be necessary, and while the connection is complicated, it is the one which is submitted as most successful solving the problem of the connection between the silica sidewalls and the flux blocks.

In connection with the tuckstone problem it would seem desirable from a thermal standpoint that the silica sidewalls of the present tanks should be increased to fifteen inches at the least. Increases over this are not to be taken entirely in one step. It is also desirable that after the first increase to fifteen inches is taken, the actual thermal efficiencies should be first compared with the theoretical before going to greater thickness. Harbison Walker Co. have published some curves from which the following interesting figures are taken:

Vertical Silica Brickwork Walls With Inside Temperature of 2600 F.

Wall Thickness	Outside Wall Temperature	B.T.U. Loss per sq. ft. per hour
12	537°F	2060
15	487°F	1675
18	450°F	1410

These figures indicate a reduction in B.T.U. loss of 385 B.T.U. per hour per sq. ft. of wall through the substitution of a 15″ wall in place of the 12″ wall. This reduction should interest tank operators as the greatest source of loss in a tank is radiation, and any savings effected through reduction of radiation losses should be readily apparent in decreased fuel consumption.

These tuckstone constructions and observations are taken from an accumulation of notes recorded over a period of years. It is hoped that this article will stimulate interest in this subject to such an extent that there will be an exchange of ideas and designs, in order that a better solution of the problem may be reached.

GLASS AT CONNECTICUT TERCENTENARY

The evolution of machinery and methods for the making of glass will be a prominent feature of the Industrial Exposition at the State Armory, Hartford, on October 2-12, in celebration of Connecticut's 300th birthday. The nutmeg state has had a long and honorable history in glass-making commencing in 1783 when William Pitkin of Manchester was granted a monopoly to manufacture glass. The exhibit promises to trace the history of this industry from Colonial days to the present, when Connecticut's chief contribution is in the form of cutting, staining and ornamenting glassware in which this state ranks fourth in the country. Its chief products today are watch and clock dials, and mirrors for vanity cases.

G. C. A. FALL MEETING

THE annual Fall meeting of the Glass Container Association was held at Atlantic City, N. J., September 19 to 21 inclusive. A large attendance was recorded, and notwithstanding the serious nature of many of the problems confronting the industry, the prevailing spirit was distinctly optimistic. Divisional meetings were held—by the cap manufacturers on Wednesday and the glass men Friday; Thursday being reserved for an open general session and for sports and entertainment.

President Walter H. McClure presided. He opened the meeting with an announcement of the recent death of Edward C. Stewart, president of the Tygart Valley Glass Company, and he said a beautifully sincere tribute to that fine old glass man. He then called on manager E. G. Ackerman to report on Association activities since the last meeting.

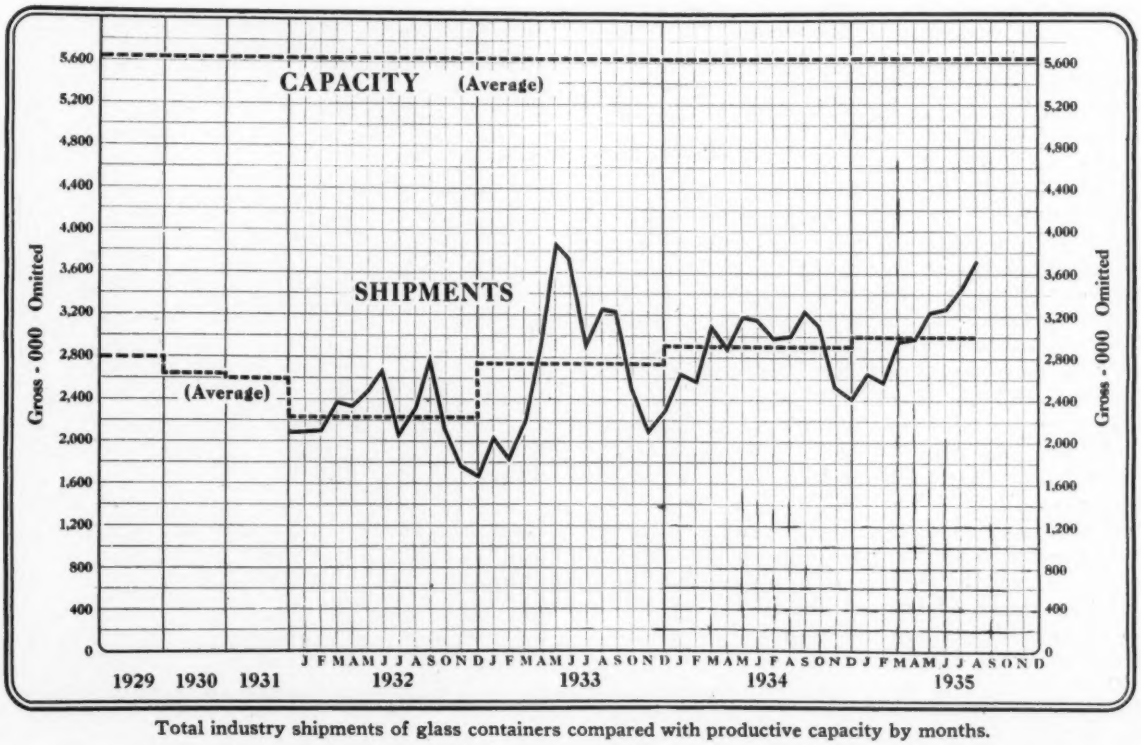
Space does not permit of recording this excellent report in detail, which registered a remarkably long list of interesting developments and genuine achievement. Some highlights, however, must be briefly mentioned. For instance, since the demise of the N.R.A. wages in cap and closure plants actually have increased, a striking contrast to many industries. Shipments of glass for the first eight months have reached a new all-time mark, exceeding both 1934 and 1929, the previous high water marks—and it is expected the final quarter will continue relatively high.

Liquor Ware. The Alcohol Control Law has been of substantial benefit, and the increase in liquor ware has helped point the production curve upward at a time it normally falls. Container manufacturers, however, were cautioned against making liquor shapes for other products, and also against making cordial bottles without the indicia of the distiller or rectifier, even though these are of distinctive shape and design.

Tariff. Importations of foreign made bottles were considerably lower for the first six months of 1935. Of interest is the fact that Japan is becoming one of the largest exporters of bottles to this country. From practically nothing she gained fifth place in 1934 and for the first half of 1935 was third. Japan now produces about 11 per cent of the total bottle importations. To date, none of the reciprocal tariff agreements has affected the bottle industry.

Beer. One of the highlights of the meeting was the campaign formulated to protect the beer bottle market against the attacks of the tin can. It was brought out at the meeting that the can companies estimated beer offered them a potential market not far below 50 per cent of their present total production—a prize well worth fighting for. To date, more than a million dollars has been spent or appropriated to put over the can (entirely aside from the original research), with still larger sums a future probability. Inevitably, such a large investment in promotion has made itself felt, and some 14 brewers have been wooed from glass to cans in 1935.

The success of the beer can is attributed largely to a consumer advertising campaign which has convinced many that canned beer is better beer, and to promotional work among retailers and brewers to persuade them that canned beer was more profitable for them in the



Total industry shipments of glass containers compared with productive capacity by months.

long run. Prominent among arguments for the latter group are the deposit and returned bottle problems. With consumers, the novelty of the can is also an important consideration.

Contrary to many newspaper reports appearing after the convention, the glass container industry, while fully awake to the menace of the tin can, is far from being panic stricken. The industry is planning a vigorous counter attack, in which facts will be arrayed against the more or less flamboyant claims of the can companies. For instance, it can be definitely shown that canned beer costs more than bottled beer, claims to the contrary notwithstanding. And canned beer, far from being better beer, has often elements (e.g., a high iron content) that makes it appear positively unsafe from a public health standpoint. Experience to date in localities where canned beer has already made headway shows that its popularity is quickly checked when propaganda is opposed with facts.

Milk. Since May 15, the Association has been conducting its counter offensive against the paper milk container. Having very much the same interests to contend with, and a competitive situation of a character quite similar, the story differs from beer only in its particulars. For several years, the paper container makers have been trying to put over their container in the milk field. Finally they developed a package that could be made successfully in the bottling plant. This they took to Philadelphia, and catching both the dairyman and the bottle maker unawares, built up a big success story. It is this story they have been merchandising to other chain stores all over the country, with a fair degree of success. The Association took cognizance of the situation last Spring. Its program constituted: (1) A thorough check of the facts of the Philadelphia success story; (2) A study of the sanitary features of the paper package, by a competent, impartial laboratory; (3) A survey of the consumer reaction to paper containers. The information gained by these studies is being given publicity and has acted to definitely check the advance of the paper container. The campaign will be continued for as long as needed; but the glass men feel they have the situation well under control.

Glass Container Production. The statistical report of Victor Hall, secretary of the Association, is always one of the most interesting features of these meetings and this year proved no exception. The accompanying chart shows the industry's shipments by months since 1931, from which it may be seen that production for the first eight months has averaged better than any previous year. Although the last quarter of 1935 is bound to show the customary seasonal decline, yet this period is expected at least to compare favorably with the average and undoubtedly will continue to keep the dotted line at least above the 1934 high. Slight gains were recorded in the Pressure and non-pressure ware, medicinal and toilet preparations, which gains became more substantial in general purpose, liquor, milk bottle and fruit jar and jelly glasses. In general, the food group was responsible for the major increases. Beer bottles, pressed and general purpose containers fell off.

Continuation of the net gain recorded above was predicted by implication in an address by Mr. Stevenson. He reminded his audience that business moves upward and downward in cycles. And just as we have been watching the pendulum swing downward since 1929, all signs point to a reversal of the movement. For the next four or five years, said Mr. Stevenson, we should expect to see a return to prosperity, unless the political situation injected factors harmful to business.

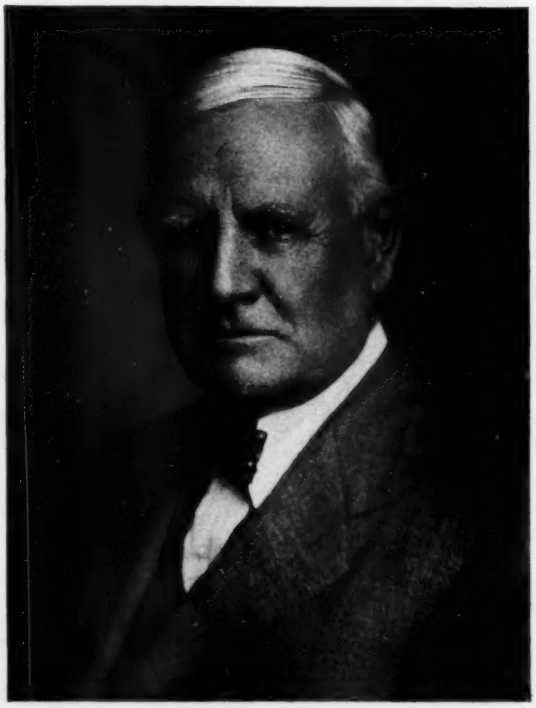
Now the tin can is making a bid for the wine industry. According to the Wine Institute of California, eight or ten of the largest wine producers in California are ready to market their products in tin. The move is described as being destined "to stimulate mass consumption"; for the better products will continue in bottles.

EDWARD C. STEWART DIES

Edward C. Stewart, president of the Tygart Valley Glass Co., died suddenly at his home in Washington, Pa., on Friday, September 13. He was stricken with a heart attack while in his office and though at first he rallied strongly, death claimed him that same night. Funeral services were attended by scores of glass men and by employees of the company.

Mr. Stewart was one of the "grand old men" of the glass industry, with which he was associated his entire business life. As far back as 1895, he was in charge of the Atlas Glass Company at Washington, which is believed to be the first factory in the United States to produce machine-made ware.

In glassmaking, Mr. Stewart held unswervering to one ideal: to make the best and only the best. His constructive ideas and his sound judgment led many in the industry to seek his advice. He was beloved by his associates and employees. In his passing, the glass container industry loses a man who has helped create its best traditions and whose absence will be poignantly felt.



EDWARD C. STEWART

REFRACTORIES DIVISION CONVENES

SIXTY individuals, directly or indirectly interested in the use or manufacture of refractory materials, registered at the summer meeting of the Refractories Division, Friday, September 19, at the Center Hills Country Club, State College, Pa. An analysis of the attendance shows that comparatively few glass men (5) were present, while 50 per cent of the registration consisted of refractory products manufacturers. The second largest group came from the metallurgical field, which had 10 representatives.

The serious work of the meeting began with a luncheon, at which Dr. R. B. Sosman, chairman of the Division, welcomed all comers and thanked the hard working committee members—Harold White, Hobart Kraner and Dr. N. W. Taylor. Dean Edward Steidle, of the School of Mineral Industries, then spoke of the closer contact between the School and Industry which had resulted from meetings of this kind, following which Dr. Taylor offered his help in deciphering a "treasure hunt" map offered to each registered guest as an aid in reaching the evening's entertainment at the Clay Workers Club.

Five papers were presented at the afternoon session, which was presided over by president McKinley. The chairman expressed his pleasure that a summer meeting of the Division had been found possible and practicable. He stated that as a result of user demands, the producer might come to see more clearly the justification for conducting research that might lead to the production of better refractories. He also voiced the hope that out of such meetings would result a more complete and more rational system of specifying specification details.

The papers presented were as follows:

Experiences in the Use of Refractories in the Steel Plant. By Louis Smith, Refractories Engineer, Jones and Laughlin Steel Co.

Refractory Problems in Basic Alloy Steel Production. By Gilbert Soler, Trinken Steel and Tube Co.

A Discussion of the Action of Coal Ash Slags on Fire Clay Refractories. By Dr. Harold E. Simpson, Research Associate, Batelle Memorial Institute.

Observations on the Behavior of Refractories in Glass Manufacture. By Dr. George V. McCauley, Research Physicist, Corning Glass Works.

Notes on Refractories for the Electrothermic Industry. By W. B. McBride, St. Joseph Lead Co.

The one paper of real direct interest to glass manufacturers was that entitled "Some Observations on the Behavior of Refractories in Glass Manufacture," by G. V. McCauley, a synopsis of which follows:

The behavior of refractories in the manufacture of glass depends largely on the physical properties of both refractory and of glass in addition of course to the chemical factors involved.

Of the physical properties belonging to the refractory the character of its bond which holds its particles together and the degree of its porosity are of major consequence.

Belonging to the glass are the properties of surface tension, viscosity and density. Of these the factors of surface tension and density are instrumental in producing the movements of glass which hasten refractory erosion while viscosity is the force of resistance which counteracts to some extent the action of the others.

The force of gravity, naturally, is an unavoidable factor which combines with density in producing glass movements.

The nature of the erosion produced by a given glass in contact with a refractory and hence the behavior of that refractory in melting the glass in question is largely determined by the interaction of these several forces.

Considering the papers as a whole, it was indicated that the bulk users of refractories seemed to feel that a more intelligent use of refractories would be exceedingly beneficial to both producer and user. The false impression that a great difference exists in the quality of the same type of brick of several advertised ratings is leading to needless waste in various places within furnaces, making it necessary to forego the installation of special and more expensive refractories in points where they would really be most beneficial. In many installations it would be more economical and better results would be obtained if, instead of using a medium quality brick throughout, a poorer quality brick were used in places not subject to severe attack and a good, expensive brick employed at points of real danger.

The loss would be greatly minimized in furnaces requiring lower and average temperatures if the furnace were designed to minimize abrasion and excessive spotty heating. There are many cases where a breakdown of the refractory in spots entails the loss of the entire refractory, much of which is still of value. More scientific instruments to give a picture of exact temperature conditions, at least for designing furnaces, if not for control, would serve as an aid in cutting costs.

A more uniform and systematic design of furnaces can be worked out much to the advantage of the manufacturers in that it would require a smaller number of molds, etc. Such systematic designing would allow the manufacturer to focus attention on improving the systematized shapes, and the producer and user would both be benefited. Improper installation, for example, often does not permit a true test of the quality of either the brick or mortar.

Other phases affecting the bulk user were discussed, such as the possible explanation for the characteristic solution patterns as exhibited by the brick after being subjected to the hot liquid baths. The ideas offered on the establishment and the variation in the concentration of the solvent explained very nicely and in a unique manner many of the phenomena quite frequently observed. Using such a picture of the mechanism of erosion leads to a more intelligent application of refractory materials of different degrees of resistivity.

Methods of testing refractory material with respect to resistance to slag action were discussed. Cases to be considered in laboratory practice as well as testing on a microscopic scale were considered.

The demands of people who require smaller quantities of brick and other refractory shapes were a challenge to the refractory manufacturers to give the best they had, thinking first of quality and, secondly, of cost. Special steel products, for example, demand high refractivity and good physical resistance, as inclusions of refractory material for steel products cannot be tolerated.

In summarizing it may be said that the convention succeeded in making two very strong impressions: First, bulk users feel that they have a variety of good refractory material available provided they are informed as to its exact limits, and then are able to use it intelligently; second, the more specialized users require manufacturers to give the best they have both in refractivity and physical resistance, regardless of cost.

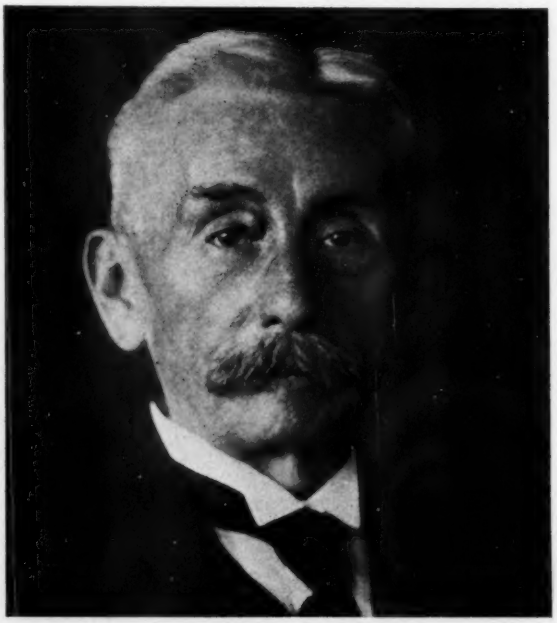
OTTO SCHOTT

On August 27, Otto Schott, founder the great Jena Glassworks, passed away at the age of 84. Dr. Schott was descended from a very old family of glass makers, and his earliest youth was spent close to the window glass factory of his father. In time, there grew within him a conviction that the simple processes and materials then used in glass making, could be greatly improved. In 1879 he took the first major step toward realizing his goal and his life's work by submitting a lithium glass to Prof. Ernst Abbe for his criticism, and thus began the life long friendship of these two great savants.

Dr. Schott built his factory at Jena just 51 years ago. His thermometer glasses soon enjoyed a world-wide reputation. The number of his optical glasses multiplied. Finally, the Prussian Government became so impressed, it lent him financial support and from that day his ultimate success was assured.

At about this time (1891) Abbe turned his great fortune over to the Carl Zeiss Foundation. Schott followed in Abbe's steps by providing in his will that his share in the Zeiss plants and the Jena Glassworks should fall to the Foundation. However, he did not wait for death to claim him, but in 1919 renounced all ownership in his business to the Foundation. He was made its business manager, a work he continued until 1927.

Dr. Schott lived a life full of endeavor, and was one of those rare individuals to whom fortune granted the fulfillment of his life's ambition. His name will always be indelibly linked with the development of glass making, and his memory fondly cherished by his countless friends.



DR. OTTO SCHOTT

I. E. S. DISCUSSES FLUORESCENT GLASS

THE twenty-ninth annual convention of the Illuminating Engineering Society was held in Cincinnati, September 3 to 6 and drew a large attendance. Papers of direct interest to the glass industry were lacking, however, as the majority of papers presented were concerned with the principles of lighting, typical applications and discussions of various lighting problems.

In a paper on Ultraviolet Radiation and Fluorescence by L. J. Buttolph and L. B. Johnson mention was made of the so-called fluorescent glasses which are being manufactured both here and abroad in an attempt to alter the color of mercury sign tubing and mercury light sources, and to add to their luminous efficiency through the conversion of invisible ultraviolet radiation inside to visible radiation outside the tube. Parts of this paper of interest to the glass technologist are reprinted below:

Partially fluorescent lamps have recently been developed using these materials as a coating or glaze on the inner surfaces of the bulb or tubes as is done with the cathode ray tubes. For the same purpose an interesting line of so-called fluorescent glass has recently become available for the fabrication of lamps in which the arc tube itself contributes a continuous or banded spectrum to the normal line spectrum of the gas or vapor used.

While lamps of this type are called fluorescent they are probably cathode—as well as photo-luminescent, and the radiation which excites their photo-luminescence is generally of so short a wave-length that it does not pass through ordinary glasses. The photo-luminescence and the fluorescence due to the direct action of cathode rays or electrons limits this light emission strictly to the inner surface of the arc tubes themselves. Since many of these materials, glasses or zinc salts, are responsive to the 250-millimicron region, they are uniquely adaptable to the mercury arc operated to secure efficient production in the arc space of the 254 and 185-millimicron resonance lines.

Two results were anticipated by the manufacturers of such tubing, a change from the monotony of red, blue, and green luminous signs, and on the other hand, new artificial sources of light, which in their effect might be compared with daylight.

It is claimed that by the addition of heavy metals (especially cadmium) to zinc silicates and zinc sulphides the color of the luminescence may be changed from greenish-white to lemon-yellow and strawberry-red. Luminescent tubing made from such glasses is claimed to give efficiencies up to 370 per cent of that of a clear glass tube. Several tubes of both foreign and local manufacture were analyzed by one of the authors for the effect of these special glasses on the character of the light and the efficiency of the source.

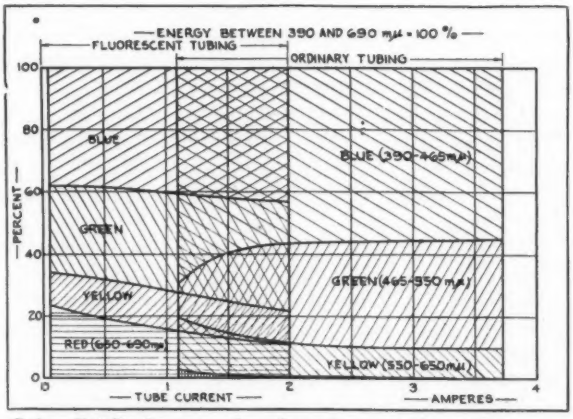
The diagram shows results of such an analysis for a sample of luminous tubing and ordinary tubing fabricated into a hot-cathode mercury lamp which could be operated over a wide range of tube current. The analyses were made with a filter radiometer, which incorporated filters of known transmission and a thermopile which was a non-selective detector of radiation.

The cross-hatched sections show the percentages of red, yellow, green, and blue energy from the lead glass and the fluorescent glass at different tube currents.

The fluorescent glass used in this case was flashed opal (a common practice in manufacturing fluorescent tubing) which glass tends to somewhat redden the light it transmits, so that some of the differences in the light from the fluorescent and ordinary tubing are caused by the opal flashing.

The noticeable differences are the much higher percentage of red energy (650-700mμ) and lower percentage of blue energy (390-465 mμ) from the fluorescent tubing, giving a more uniform energy distribution.

For each band of energy, it should be observed that the analysis of the fluorescent lamp is tending toward that of the lead lamp as the current is increased. If clear fluorescent glass had been used, the tendency would have been more easily shown. Opal glass reduces the percentage of blue and thus the percentage of red is increased by a subtractive process.



Color distribution as a function of current in mercury arcs with and without fluorescent arc tubes.

The increase of the percentage of fluorescent radiation is brought out more clearly by spectrograms of the luminous tubing lamp operated over a wide range of tube current. Spectrograms were made at 0.05, 0.5, 2.0, and 4.0 amperes tube current. This approximate relationship (reciprocity law) was about equivalent to moving the light source away from the spectrograph so that the amount of light incident on the slit of the instrument was the same for each exposure.

The spectrogram for 0.05 ampere, shows the usual mercury line spectrum and in addition a continuous spectrum due to fluorescence and also three bands centered at 400, 430 and 540 mμ probably due to fluorescence. The red mercury lines at 623, 612, 607, and 568 mμ, which are not ordinarily seen in the spectrograms of mercury sources because of their low relative intensities at the current and vapor pressure at which most mercury spectrograms are taken, are of such relative intensity, at 0.5 amperes, that they are the cause for the increase of red light in the ordinary glass tube at currents less than 1.5 amperes. Spectrograms were taken at 0.5, 2.0, and 4.0 amperes respectively, and show

a successive apparent weakening of the fluorescent spectrum as the current is increased. This shows why the analysis of the luminous tubing approaches the ordinary tubing at higher tube currents.

No data as to the actual relative intensity of the fluorescent spectrum in the red and blue can be obtained from the spectrograms because of the unknown difference of photographic film sensitivity for the two regions. They do show, however, that as the tube current is increased, the amount of fluorescent light becomes relatively weak.

The total light increases from 0.05 to 4.0 amperes is 7,000 per cent. The normal operating current of a mercury tube is about 4.0 amperes. A fluorescent light source to properly utilize the effects of fluorescence would have less than 1/70 of the light output of a standard glass tube of the same diameter, in the case of a fluorescent Cooper Hewitt 50-inch tube approximately 1/70 of 7,000 lumens or 100 lumens.

One luminous tube lamp operated at 0.05 ampere gave a light output 2½ times greater than a similar lead glass tube. At four amperes the output of each was practically the same.

If one desired to utilize the increased luminous efficiency and the advantageous addition of a continuous spectrum giving a light of better color value, it would be necessary to use many more lamps or to re-design the lamp, to have enough light.

If a fluorescent glass lamp gives 2½ times as much light as a lead glass lamp of the same tube diameter, then assuming the transmission of the glasses is the same, 40 per cent of the light is from the arc, and 60 per cent from the fluorescence.

Fluorescent tubes for sign purposes may be obtained in a variety of colors and, from what can be determined from the literature obtained from manufacturers, have been used in Europe with considerable success. German manufacturers claim from 80 to 300 per cent more light from certain kinds of tubing.

The use of fluorescent glasses which are dependent upon short wave-length ultraviolet for their excitation will decrease in light emission if dirt or other material of poor ultraviolet transmission comes between them and the source of ultraviolet.

The greatest of care must be used to keep traces of dirt or air from the tubes during fabrication to obtain high efficiency in operation.

In all mercury discharge tubes and arcs a film of material (probably mercury combined with some elements of the glass) is formed which causes some decrease of light output. It has been reported that such films do considerably reduce the efficiency of such fluorescent light sources as have been outlined above.

It has not been the purpose of the authors to say that fluorescent light sources will never be feasible. At the present time no material has been found which can convert the blue, violet and ultraviolet energy of a mercury lamp with sufficient efficiency to add materially to the light of the lamp under present design and most efficient operating conditions. It has been stated above that in a Cooper Hewitt lamp the amount of ultraviolet energy going to waste because of its invisibility is 1½ times the quantity of visible light. An efficient conversion of this energy to visible light of a continuous spectrum would result in a light source of good color value and nearly double the light output. Such a material must be stable enough to withstand the temperatures which the tube undergoes during the pumping process, (360 deg. C) and it must be of high light transmission to that light which does not activate fluorescence, so that its presence in the glass or in the tube wall will not reduce the light from the arc itself.

OPTICAL SOCIETY CONVENTION

The 20th annual meeting of the Optical Society of America will be held at The Franklin Institute, Philadelphia, Oct. 24-26. A visit to the Fels Planetarium as well as an exhibit in optics at the Museum of the Franklin Institute will be features of the meeting. A special program of invited papers on the microscope and microscopy will be presented in addition to more general papers.

The war between metal and glass radio tubes is not yet over. Philco let loose with another full page advertisement last month with most convincing statements as to the superiority of glass. Query: Why do the glass tube makers leave all the fighting to Philco? Or do they?

PUBLICATIONS RECEIVED

Technical News Bulletin. Number 221. September, 1935. National Bureau of Standards, Washington, D. C.

A brief treatment of "Relative Durability of Optical Glass," based on the Bureau's tests with the effects of acid and alkaline solutions.

Industrial Standardization and Commercial Standards Monthly. Vol. 6, No. 9, September, 1935. American Standards Association, New York.

Contains several noteworthy articles. Of particular interest to members of the glass industry are "New School Buildings Meet ASA Lighting Provisions" and "Specifications Encourage New Lamp Designs." The latter article refers briefly to the Illuminating Engineering Society's specifications for lamps.

Minerals Yearbook 1935. United States Bureau of Mines.

Statistics, economics and the trend of developments in mining in the United States. It includes data from various publications, among them "Mineral Resources of the United States" which is no longer published. For a copy, send $2.00 to the Superintendent of Documents, Government Printing Office, Washington, D. C.

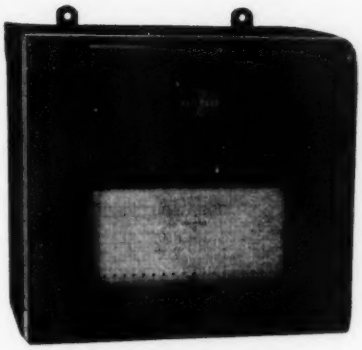
Mineral Trade Notes. Vol. 1, No. 3. Sept., 1935. United States Bureau of Mines.

Notes on the mineral situation from various parts of the world. Among the raw materials treated are chromite and cobalt.

Verrerie Scientifique Speciale pour L'Astronomie, L'Optique et La Photographie. Societe Anonyme des Etablissements Parra-Mantois et Cie, Paris.

This very attractively presented publication with many illustrations including a very handsomely lithographed frontispiece, gives a chart of the various glasses with their compositions to be used for astronomical, optical and photographic glass. Complete charts of the indices of refraction for various crown and flint glasses are given.

EQUIPMENT AND SUPPLIES



NEW PYROMETER ON POTENTIOMETER PRINCIPLE

The Wide-Strip Pyrometer, just introduced by Bristol Co., Waterbury, Conn., operates on a potentiometer principle of temperature measurement and is available in single-record, multiple-record and recorder-controller types. The recordings are made on a 12¼ inch chart with a 1¼ inch indicating scale that may be read at a distance.

The principle of operation of this device is said to be entirely new in its field. A stainless steel lead screw, operated by an electric motor under two galvanometer controlled contacts, adjusts the slide wire contact and recording-pen unit to maintain emf balance in the potentiometer system. This balancing mechanism makes it possible to magnify scarcely perceptible deflections of the galvanometer pointer; deflections smaller than 1/1000 of an inch are claimed to be easily measured. The slide wire contact and recording pen are mounted on the same carriage to eliminate errors due to backlash, lost motion, etc.

Other features pointed out by the company are a convertible case which is moisture, dust and fume-proof, fully automatic operation and easy serviceability by the user.

PITTSBURGH AGENT MOVES

Walter S. Aylsworth, Pittsburgh representative for The Chas. Taylor Sons Company, manufacturers of P. B. Sillimanite, Taylor Refractory Insulating Brick, Tiger Steel brand fireclay brick and refractory specialties, announces removal to larger quarters, located in the Martin Building, Pittsburgh, Penna.

Charles C. Carmody, formerly with Frederick, Traugott, Allen & Company, has become associated with Mr. Aylsworth in the sale of the above products.

APPOINT DETROIT REPRESENTATIVE

General Refractories Company, Philadelphia, Pa., have appointed The Chas. A. Strelinger Co., Detroit, Michigan, as Dealer Agents in the Detroit area. The Chas. A. Strelinger Co. will carry a complete stock of refractories in addition to their well rounded line of industrial supplies.

NEW HEATING ELEMENT

The C. O. Jelliff Manufacturing Corporation, Southport, Conn., is now marketing a new electrical resistance alloy, which is said to have an operating temperature of better than 2460°F. and remarkable oxidation resisting properties. Kanthal, as it is called, is also claimed to be perfectly free from attack in the presence of sulphur.

Three grades of Kanthal are available: A-1 for a maximum temperature of 2462°F., for electric furnaces; A-1 for a maximum of 2373° F., for domestic appliances; and D for a maximum of 1150°F., for most purposes where nickel chrome is now used.

The Jelliff Corporation will supply, on request, a booklet describing the Kanthal Alloys in full particulars as to composition and properties.

CATALOGS RECEIVED

Setskold C-9, Hot and Cold Patching Super Cement and Bonding Mortar. Laclede-Christy Clay Products Co., St. Louis. Recommends this product for laying up refractory materials in severe locations, rebuilding purposes and hot patching. Also gives specifications and drawings for their various blocks, tuck stones, floaters and silica brick.

Facts About Built-Up Roofs. Johns-Manville, 22 East 40th St., New York. Construction details of most commonly used roofs, plus a table giving surface, underwriters' rating, materials of construction and weight per 100 sq. ft. for many types. Treats water-proofing, flashing and insulation.

Time Switches. Catalog GEA-1427D. General Electric Co., Schenectady, N. Y. This catalog supersedes GEA-1427C and describes in detail general-purpose automatic time switches, Types T-17 and T-27, with prices for various installations. Also suggests possible uses.

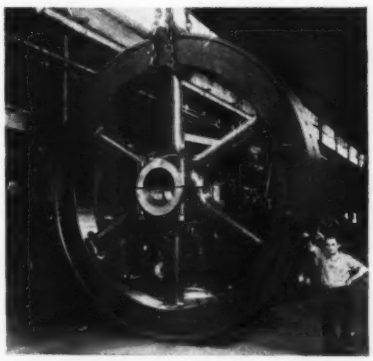
"Over the Rough Spots." Stonhard Co., Philadelphia, Pa. A profusely illustrated 24-page booklet on efficient and economic maintenance of plants and business properties. Offered as a guide towards keeping floors, roofs, walls and foundations in good repair.

Nickel Manganese Steel Welding Rod. Bulletin No. 10. American Manganese Steel Co., Chicago, Heights, Ill. Describes purpose and properties of this type of welding rod with testimonials of users and suggestions for proper methods of using the rods. U. S. Pat. 1,815,464.

LARGEST OF ITS KIND

Power-plant facilities of the Owens-Illinois Glass Company are being stepped up 25 per cent, at Kanawha City, W. Va. A new 1350 hp. Cooper-Bessemer gas engine is being installed—one of the largest units of its kind ever placed in West Virginia. Modern in design and impressive in size, the new engine weighs 400,000 pounds. The huge flywheel, shown in the accompanying photo, alone weighs 60,000 pounds. Ben Paulson, "dean" of Cooper-Bessemer erecting engineers, is supervising the job.

Since 1916, the glass company has been developing its own power with natural-gas engines, and it is said to have never had a complete power failure.



CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	...	.29
Hydrochloric (HCl) 20° tanks	Per 100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	...	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 130 lb. carboy ext.	Per 100 lb.	...	5.50
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	...	Po. or Gr. .25 / Cry. .25½
Aluminum hydrate ($Al(OH)_3$)	lb.	.04-.04½	.04½-.05
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Ammonium bicarbonate (f.o.b. works)	lb.	.0515	...
(f.o.b. N. Y.)	lb.	...	.0571
Ammonium bifluoride (NH_4FHF)	lb.	...	.14½
Ammonium nitrate (NH_4NO_3)	lb.	...	.08
Ammonia water (NH_4OH) 26° drums	lb.	...	.02¼
Antimonate of Sodium	lb.	...	.10½
Antimony oxide (Sb_2O_3)	lb.	...	.13
Antimony sulphide (Sb_2S_3)	lb.	...	.13
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03½	.04-.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	40.00	45.00
90% through 100 mesh	ton	37.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	.049	.05½
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.07¾
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Bone ash	lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.022	.0245-.027
Powdered	In bags, lb.	.0245	.027-.0295
Boric acid (H_3BO_3) granulated	In bags, lb.	.05	.0525-.055
Cadmium sulphide (CdS) —	lb.	...	.90-.95
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Chromite	lb.	...	.0215
Cerium hydrate 100 lb. drums and 600 lb. barrels	lb.	...	.65
Chrome Oxide Green, 400 lb. bbls.	lb.	.17	.215-.25
Cobalt oxide (Co_2O_3) In bbls	lb	...	1.39
In 10 lb. tins	lb.	...	1.49
Copper oxide Red (Cu_2O)	lb.	...	.25
Black (CuO)	lb.	...	.15
Black prepared	lb.	...	.22
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08	.08½
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	...	2.30
Feldspar— 20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%) Bulk, carloads, f. o. b. mines	ton	30.50	...
In bags	ton	32.10	38.00-40.60
Formaldehyde, bbls.	lb.	...	.07
Graphite (C)	lb.	...	.04-.07
Iron oxide— Red (Fe_2O_3)	lb.	...	.0425
Black ($Fe3O_4$)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Kaolin (f. o. b. mine)	ton	8.00-9.00	...
English, lump, f. o. b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	...	.16
Lead oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.07	...
In 5 Ton lots	lb.	...	.075
Less than 5 Tons	lb.	...	.08

		Carlots	Less Carlots
Lime— Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Limestone ($CaCO_3$)	ton	1.75-2.50	...
Litharge (PbO) (New York Prices)	lb.	.06	...
In 5 Ton lots	lb.	...	.065
Less than 5 Tons	lb.	...	.07
Magnesium carbonate ($MgCO_3$)	lb.	.06	.08-.09
Magnesium sulphate (U.S.P.)	lb.	...	.0265
Manganese, Black Oxide In Paper bags	ton	50.00	52.50-55.00
In Burlap bags	ton	51.50	54.00-56.50
In Casks	ton	53.00	55.50-58.00
Neodymidm oxalate, 50 lb. drums	lb.	...	5.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Plaster of Paris, bags	ton	31.00	23.00 29.00
Potassium bichromate ($K_2Cr_2O_7$)— Crystals	lb.	...	.08⅝
Powdered	lb.	...	.09⅛
Potassium carbonate Calcined (K_2CO_3) 96-98%	lb.	.06⅞	.07⅜
Hydrated 80-85%	lb.	.06	.06¼-.06⅛
Potassium chromate (K_2CrO_4) 450 lb. bbls.	lb.	...	.16
Potassium hydrate (KOH) (caustic potash)	lb.	.06¼-.06½	.08-.08½
Potassium nitrate (KNO_3) (gran.)	lb.	...	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	...	.19
Powder blue	lb.	...	.18¾
Rare earth hydrate 100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Rochelle salts, bbls	lb.	...	.12½
Rouge	lb.	...	Po. or Gr. .13½ / Cry.
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Selenium (Se) In 100 lb. lots	lb.	...	2.00
In lesser quantities	lb.	...	2.10
Silver nitrate ($AgNO_3$) . (100 oz. bot.) per oz.		...	.39
Soda ash (Na_2CO_3) dense, 58%— Bulk	Flat Per 100 lb.	1.10	...
In barrels	Per 100 lb.	1.50	...
In bags	Per 100 lb.	1.25	...
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.06½
Sodium chromate ($Na_2CrO_4 10H_2O$)	lb.	...	.08
Sodium fluosilicate (Na_2SiF_6)	lb.	.04¼	.05¼
Sodium hydrate (NaOH) (caustic soda) Flake	Per 100 lb.	3.00	...
Solid	Per 100 lb.	2.60	...
Sodium nitrate ($NaNO_3$)— Refined (gran.) in bbls.	Per 100 lb.	...	2.00-2.25
95% and 97% Bulk	Per 100 lb.	1.175	...
200 lb bags		1.24	1.29
100 lb. bags		1.275	1.325
Sodium selenite (Na_2SeO_3)	lb.	..	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	...	1.50 1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)— Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Tin chloride ($SnCl_2$) (crystals) in bbls.	lb.	...	.37
Tin oxide (SnO_2) in bbls	lb.	...	.53
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	3.00
Yellow orange	lb.	...	1.50
Zinc oxide (ZnO) American process, Bags	lb.	.0575	.06
White Seal, 150 lb. bbls.	lb.	.10½	.10⅞
Green Seal bags	lb.	.09½	.09½
Red Seal, bags	lb.	.08½	.08½
Zircon Granular (Milled .005-.02c higher)		.07	.67½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

GLASS DIVISION MEETING

(*Continued from page* 304)

a water bath. In the case of the thinner glasses, with which a water bath would not produce a temperature differential sufficient to cause failure, the use of an air bath or a diethylene glycol bath was necessary.

The thermal endurance tests were made as follows: The samples were heated in a suitable bath for 5 to 15 min., depending upon the glass thickness. When temperature equilibrium was reached, the glass samples were removed and rapidly transfered to a bath containing water and crushed ice. The bath was stirred while making the test. The samples remaining unbroken were reheated 1°C higher and again removed to the cold bath. This procedure was followed until all specimens in a test lot were broken. Approximately 10 samples of each glass were tested.

The conclusions drawn from the work are as follows: The average temperature differential is inversely proportional to the thickness of the glass and is also inversely proportional to the coefficient of expansion. If the temperature differential is plotted against the product of the expansion coefficient and the thickness, a smooth curve that approximates a rectangular hyperbola is found. This indicates that other factors such as tensile strength, modulus of elasticity and heat conductivity are approximately the same for the glasses tested or that they compensate in such a manner than the relationship shown by the curve holds true.

Modulus of Rupture and Thermal Shock Resistance at Elevated Temperature, *By J. S. Gregorius, Pittsburgh Plate Glass Co.*

In the modulus of rupture tests, the flat glass strips were mounted in an electric resistance furnace and broken by a cantilever type machine using falling shot as the force. All samples were in the annealed condition and contained a residual stress equal to 20 to 30 m. birefringance per inch of glass path.

Five specimens of each glass were tested at each temperature and the average result recorded. Using 100 as the room temperature modulus the relative strength values at various temperatures were determined.

The conclusions permissable from the work were:

1. Modulus of rupture decreases with rise in temperature.

2. The modulus of rupture decreases with temperature until such temperature is reached where the modulus appears to increase. It is probable that this phenomena is associated with flowage and that the modulus would continue to decrease if the load could be applied in zero time.

In determining the thermal shock resistance the specimens were prepared by grinding and slightly beveling the edges of 2 x 2 x 0.288" flat glass plates. The samples were placed in a wire basket and heated in an electric furnace to a predetermined temperature. After equilibrium was reached the basket and sample were removed and plunged into a cold bath, the temperature of which was kept constant. The heating temperature was then increased in S°F steps until the samples broke. If the same differential caused the breakage of a second set the value was accepted. Paraffin and a molten alloy (Sn, 70%, Pb, 30%) were used as chilling media.

The conclusions drawn from the results are that the resistance to thermal shock decreases with increase of specimen temperature until the lower annealing temperature is reached. When the temperature of the chilling medium is in this range the resistance apparently rises toward infinity. Glass ruptures upon chilling when the chilling stress exceeds the thermal resistance of the glass. From the conception of the mechanics involved in thermal shock tests, the tensile strength of the glass is probably the most influential factor, followed by the coefficient of expansion, in influencing the resistance of glass to thermal shock. Glass in chilling tests always ruptures in its outer layers.

As suggestions for further investigation the following were presented: Locating with more precision the temperature of the chilling medium, where the thermal resistance appears to rise to infinity; the determination of the modulus of rupture and the thermal shock resistance of glass at sub-room temperature; the development of a method of determining tensile strength in which uncontrollable variables are at a minimum.

PROGRESS REPORT ON DURABILITY TESTS

In the absence of Dr. Lundell, the latest results of the various laboratories cooperating on the durability tests was given by Dr. Finn. Good agreement is now being obtained with Method No. 1 on both the bottle glass and the sheet glass. Sufficient results with the Sheffield method have not been received to give a good comparison. The few received, however, show large variations. A complete report on this subject will be given at the next meeting of the Glass Division.

FELDSPAR

THAT FULLY MEETS YOUR REQUIREMENTS

Whatever type of glassware you manufacture, you will find Seaboard can meet your particular feldspar requirements. Leading glass houses have used Seaboard Feldspar consistently for many years.

THE SEABOARD FELDSPAR CO.

Hearst Tower Building

Baltimore, Maryland

BOOKLET ON BORAX

Pacific Coast Borax Co., 51 Madison Ave., New York, has issued a 60-page booklet, entitled "Modern Commercial Glasses," which treats boric oxide and other minor constituents of glass. The salient points governing the use of borax and other constituents of modern glass batches are covered on the basis of practical experience and the advice of Dr. W. E. S. Turner of the Department of Glass Technology, Sheffield University, England.

Among the constituents discussed are alumina, barium oxide, boric oxide, magnesia and zinc oxide. These elements in the composition of glass are presented as to their various properties and functions in the making of a satisfactory batch. Purity, strength, durability, handling and mixing, working properties, fluxing, corrosive nature and color and appearance of each are given.

Borax is treated more fully particularly as regards its influence on the finished product. It stresses the well-established property of boric oxide in decreasing the expansivity of the glass and thus improving the thermal resistance of the finished product. Another beneficial effect of boric oxide mentioned in the booklet is its part in the elimination of such faults as "salt-water" stones, devitrification and cloudiness in glass due to chlorides and sulphates.

Production of polished plate glass by the member companies of the Plate Glass Manufacturers Association for the month of August, 1935, totaled 14,526,312 sq. ft., as compared to 13,908,529 sq. ft. produced in July.

TABLEWARE SPECIFICATIONS

Proposed revisions for Federal Specification No. 121a for Tableware and Glass (DD-T-101) are now available. They apply to U. S. Army, Marine Corps, Navy Department and Panama Canal specifications. Comments and criticism of these specifications should be mailed to the Federal Specifications Division, Room 751, Federal Warehouse, 9th & D Sts., Washington, D. C., before October 10, 1935.

GLASS PLANT MAN:—Graduate Chemical Engineer who has been Plant Manager and Superintendent for four years is looking for an opportunity where extensive plant operation experience as based on a sound engineering and technical training, can be put to full advantage. Address Box 25, THE GLASS INDUSTRY.

WT

BOTTLES

FULL AUTOMATIC
MACHINE PROCESS

Whitall Tatum Company

Manufacturers Since 1836

Philadelphia New York

FACTORIES: MILLVILLE, N. J.

DRAKENFELD ANNOUNCES

Jack Frost

AN EFFICIENT FROSTING COMPOUND

10 Reasons why you should use Jack Frost:

1. Gives a superior finish—a perfectly even satin-smooth finish that is truly a revelation.
2. Chemically uniform. You can always depend upon every lot being just like the last one. Removes all uncertainty from results.
3. It will not deteriorate. Good till the last drop.
4. Economical. No special equipment needed. No time consumed in mixing or other forms of preparation. No waste—use it until gone. Tests show 1.4 lbs. will frost 1 gross of 4-ounce bottles.
5. Convenient. Comes to you as a liquid in ready-to-use form. Just open the container and go to work.
6. It is safer to use than other compounds and reduces the hazard to the operator.
7. Odorless. Does away with exhaust equipment provided ventilation is normal.
8. No special lead tanks needed. Many glass manufacturers use ordinary wood tanks lined with sheet metal, both for storage and for the etching bath.
9. Permanent results. It actually etches the glass and the finish cannot be removed.
10. Backed by Drakenfeld — 65 years of service to the glass industry.

Send for folder describing method of using Jack Frost and other detailed information.

Distributed by

B. F. DRAKENFELD & CO., INC.

Established 1869

45-47 Park Place . . . . . New York, N. Y.

Washington, Pa. E. Liverpool, Ohio

"GLASS PLANT ENGINEERS"

Training and practical experience fit Toledo Engineering Co. engineers to give you advanced designs without resorting to freak creations.

We specialize in Furnace designs, construction and alterations.

THE TOLEDO ENGINEERING COMPANY, INC.

958 Wall Street Toledo, Ohio

BORAX AND BORIC ACID

Twenty-Mule-Team Brand

Guaranteed 99½% to 100% Pure

Makes Glass More Durable and Resistant

Free Booklet on Request
"MODERN COMMERCIAL GLASSES"

Pacific Coast Borax Company

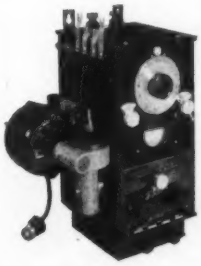
Department G

51 Madison Avenue, NEW YORK, N. Y.

KNIFE-EDGE DETECTION

Means

Better Temperature Control!



Unaided eyes can't see a movement of 1/1000th or 2/1000th of an inch. But the acutely sensitive Foxboro Potentiometer Controller can detect this small movement **and exert control action accordingly!** When the temperature in your furnace, kiln or lehr begins to vary slightly, the galvanometer pointer of the Controller need deflect as little as 1- or 2/1000th of an inch, to cause the instrument to change the valve setting and restore the control temperature. There is no "dead-spot" in the Foxboro Controller. When the pointer deflects, control action follows. The result is: **close temperature control**—the kind you need for quality products.

Investment is surprisingly small—particularly if you can group several Controllers and operate them with one drive unit.

NEW BULLETIN NO. 202

GIVES FULL DETAILS.

Send for your copy.

THE FOXBORO COMPANY

34 Neponset Ave., FOXBORO, MASS., U.S.A.

Branches in 20 Principal Cities.

POTENTIOMETERS
Indicating
Recording
Controlling
MILLIVOLTMETERS
Indicating
Recording
ELECTRIC RESISTANCE THERMOMETERS
Indicating
Recording
Controlling

FOXBORO
REG. U. S. PAT. OFF.
PYROMETERS

• THE FOXBORO COMPANY • FOXBORO, MASS. •

THE OTTAWA SILICA COMPANY

OTTAWA, ILLINOIS

ETERNAL AS THE SANDS OF TIME

The PRINCE of GLASS SANDS

The Famous OTTAWA WHITE SAND

THREE PLANTS TO SERVE YOU

OPERATING YEAR AROUND

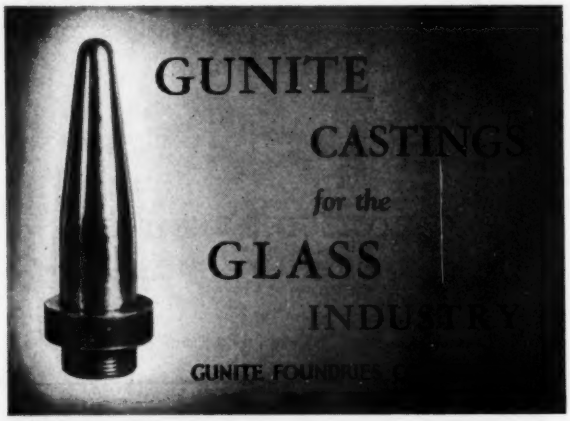
CRYSTAL SILICA 99⅝% PURE

THE SHARP-SCHURTZ COMPANY

CHEMISTS AND CONSULTING ENGINEERS

FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.



GLASS SPECIALTIES

Transparent Colored Blown Sheet Glass
Solid Pot Opal Blown Sheet Glass
Flashed Opal Blown Sheet Glass
Colonial Antique Colored Glass
Heat-Ray Resisting (Cool Glass)
"TWIN-RAY"—
the scientific
illuminating
glass.

HOUZEX

L. J. HOUZE CONVEX GLASS CO.
Point Marion, Penna.
New York Office: 110 West 40th St.
Chicago Office: 1597 Merchandise Mart
"IF IT'S MADE OF GLASS, ASK US FIRST"

BAILEY & SHARP CO.
INCORPORATED

CONSULTING ENGINEERS

GLASS TECHNOLOGISTS

CABLE ADDRESS "SHARPGLASS"

HAMBURG, N. Y. U. S. A.

Make them "Standard Equipment" in your factory—

SUPERFLUX BLOCKS

A LACLEDE-CHRISTY PRODUCT

SAINT LOUIS, MO.

Good Books
for the Glassman

In answer to many requests for books relating to glass and its manufacture THE GLASS INDUSTRY presents the following selection of interesting and informative works:

Defects in Glass By C. J. Peddle	$6.00
Electrical Properties of Glass By J. T. Littleton and G. Morey	3.00
Ceramics (a handbook) By A. Malinovszky	3.00
Ceramic Tests and Calculations By Prof. A. I. Andrews	2.25
Decorative Glass Processes By A. L. Duthie	3.50
Industrial Furnaces (Vol. 1)	6.00
Industrial Furnaces (Vol. 2) By W. Trinks	5.50
Fuels and Their Combustion By Haslam and Russell	7.50
Industrial Stoichiometry By W. K. Lewis and A. H. Radasch	2.50
Non-Metallic Minerals By R. B. Ladoo	6.00
Refractories By F. H. Norton	6.00
Silica and Silicates By J. A. Audley	6.00

Send remittance with your order, or, if you prefer, instructions that we forward C.O.D. Prices quoted on foreign books are subject to exchange fluctuations.

The Glass Industry

Woolworth Bldg. New York City

Hydrated

CARBONATE OF POTASH

83/85%

Manufactured now at Niagara Falls, N. Y.

A *New Domestic* product now made in *Crystals*, of uniform quality, especially for the Glass Industry.
Delivered in 400 lb. Barrels.
Generous samples sent on request.

JOSEPH TURNER & COMPANY

500 Fifth Ave., New York, N. Y.

Suppliers of Chemicals for over 70 years

MADE IN U.S.A.

DESIGNS
MODELS
MOULDS
MOULD CASTINGS
Quality and Quick Service
....250 EMPLOYEES
OVERMYER
MOULD COMPANY
WINCHESTER
IND.

Special Offer on Books

Through a special arrangement with the publishers, The Glass Industry is able to offer its readers the following books at savings as high as 70% of original list price. Only a limited supply available—order now!

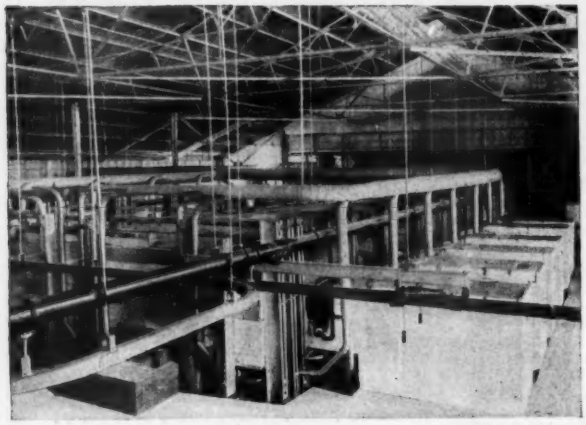
Title	Author	Special Price
Chemical Engineering Text-book of	Hart	$2.00
Physical Chemistry, Text-book of Practical	Fajans	2.50
Carbonization, Low Temperature	Gentry	1.50
Ores, Methods for Analysis of	Phillips	.75
Metallic Objects Electrolytically, Production of	Pfanhauser	.75
Analysis, Qualitative	Hill	.75
Analysis, Qualitative Chemical	Hinds	1.00
Iron and Steel, Determination of Sulphur	Pulsifier	1.00
Metallurgical Analysis	Ziegel	.75
Metallurgy	Wysor	3.00

Send remittance with order, or, if you prefer, books will be forwarded C.O.D.

The Glass Industry

Woolworth Bldg. New York City

KIRK & BLUM
Blower Systems



K & B Improved Tank Cooling System installed in plant of Scoby Sheet Glass Co., Sistersville, W. Va. Note streamline fittings and long radius elbows—features that assure greater air pressure with less power.

K & B Cooling Systems Pay for Themselves

Kirk & Blum Cooling Systems reduce power costs, prolong the life of the tank, minimize replacements, increase production. Records from installations in many of the larger glass manufacturing plants throughout the country show that because of the savings thus effected, K & B Blower Systems soon pay for themselves.
Our engineers will, without any obligation, analyze your cooling problem and advise where and how savings, if any, may be made.

Tank and machine building of Scoby Sheet Glass Co., Sistersville, W. Va.

THE KIRK & BLUM MFG. CO.
2804 Spring Grove Ave., Cincinnati, Ohio

Chicago Office: 3843 N. Central Park Ave.
Pittsburgh: The Bushnell Machinery Co., 1501 Grant Bldg.
Louisville: Liberty Blow Pipe Co., Inc., 325 Roland St.

MIN-OX
RESISTS SCALE

Regarding Moulds . . . . . .

MIN-OX alloys increase the brilliancy of the glass—greatly reducing or completely eliminating fire finishing.

MIN-OX Castings:—a series of alloys to meet varying glass production requirements.

THE
BINNEY CASTINGS
COMPANY
Toledo, Ohio

Originators Of Alloys For Glass Moulds.

Let us tell you about the

NEW DOMESTIC

ISCO CARBONATE OF POTASH

Calcined 96/98%
Hydrated 83/85%

Special Glassmakers Grades now made at Niagara Falls

INNIS, SPEIDEN & CO.
INCORPORATED
117-119 LIBERTY STREET, NEW YORK.

Chicago Cleveland Gloversville Boston Philadelphia

ISCO CHEMICALS